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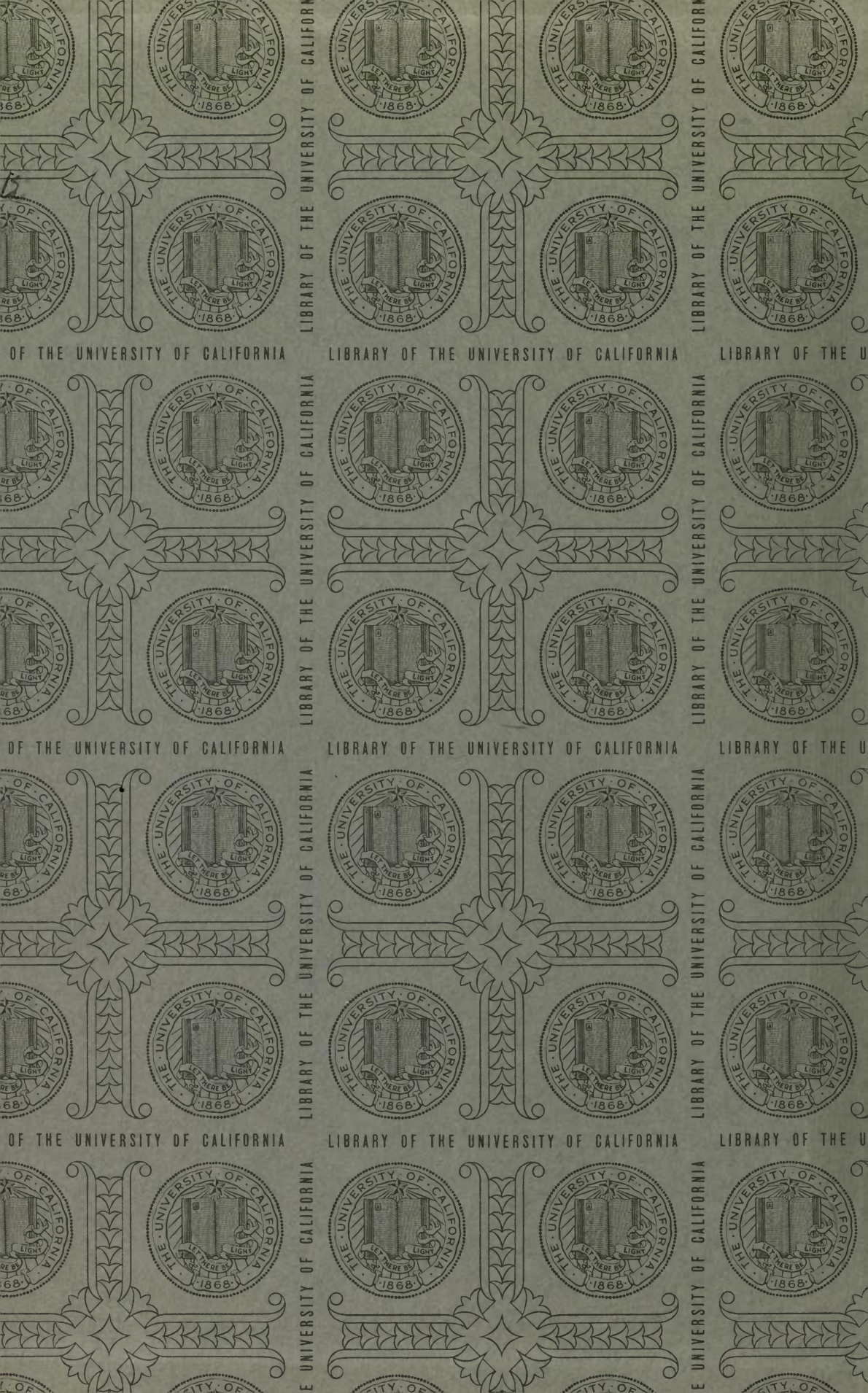
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NOTES TO ACCOMPANY THE LECTURES ON ECONOMIC GEOLOGY DELIVERED AT CORNELL UNIVERSITY? 1890 BY J.F.KEMP.

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INTRODUCTORY.

In the advance of geological science the standpoints from which the strata forming the earth's crust are regarded necessarily change , and new points of view are established . In the last few years two have become especialy prominent , and we may now say that there are two quite sharply contrasted positions from which to obtain a conception of the structure and development of the globe . The first is the physical , the second the biological . We may for example consider the surface of the earth as formed by rocks differing in one part and another , and these different rocks , or groups of rocks are known by different names . The names have no especial reference to the animal remains found in them, but merely indicate that series of related strata form the surface in particular regions. On the other hand, the rocks are also regarded as having been formed in historical sequence, and as containing the remains of organisms characteristic of the period of their formation. They illustrate the development of animal and vegetable life and in this way afford material for historical , biological study . In the original classification the biological and historical considerations are all important . But when once the rocks are placed in their true position in the scale , and are named , these considerations for many purposes no longer concern us . The formations are regarded simply as members in the physical constitution of the outer crust . The International Geological Congress held in Berlin in 1885 expressed these different points of view in two parallel and equivalent series of geological terms, which are tabulated below . They are now very universally adopted. For clearness in illustration , the equivalent terms employed by Dana are appended to them .

Physical Terms.	Biological Terms.	Equivalent Terms employed by Dana.	Illustrations.
Group.	Era.	Time.	Palaeozoic.
System.	Period.	Age.	Devonian.
Series.	Epoch.	Period.	Hamilton.
Stage.	Age.	Epoch.	Marcellus.

In considering the ore deposites of the country we employ only the physical terms . We of course understand the chronological position of the systems in the historical sequence , but it is of small moment in this connection what may be the forms of life enclosed in them . The purely physical character of the rocks , whether crystalline or fragmental , whether limestone , sandstone, granites or schists are the features on which we lay especial stress . The classification briefly summarized is as follows .

ARCHAEAN GROUP. I. Laurentian System. II, Huronian System. (Additional subdivisions have been introduced by Canadian and Minn. geologists. Animikie, etc.)

PALAEOZOIC GROUP. III. Keweenian System. (This may belong with the Archaean.) IV. Cambrian System. (a) Acadian Stage. (b) Potsdam

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INTRODUCTORY.

Stage. (c)Lower Calciferous Stage. V Lower Silurian System A, Canadidn Series. (a)Upper Calciferous Stage. (b) Quebec Stage. (c) Chazy Stage. (This will probably experience revision.) B, Trenton Series. (a)Trenton Stage. (b)Utica Stage. (c)Cincinnati or Hudson R. Stage. VI. Upper Silurian System. A.Niagara Series. (a)Medina Stage, (b)Clinton Stage, (c)Niagara Stage. B.Salina Series. C,Lower Helderberg. D,Oriskany Series. (The Oriskany may be made the base of the Devonian). VII,Devonian System.A.Corniferous Series, (a)Cauda-Galli Stage, (b)Schoharie Stage, (c)Corniferous Stage, B,Hamilton Series,(a)Marcellus Stage, (b)Hamilton Stage, (c)Genesee Stage, C,Chemung Series. (a)Portage Stage, (b)Chemung Stage. D,Catskill Series. VIII,Carboniferous System. A,Subcarboniferous Series. BCarboniferous Series. C,Permian Series.

MESOZOIC GROUP. IX,Triassic System. X,Jurassic System. IX & X are not sharply divided in the U. S. and we often speak of Jura-Trias. XI,Cretaceous System.(Subdivisions differ in different parts of the country). Atlantic Border,(a)Raritan Stage, (b)N.J. Greensand Stage. Gulf States, (a)Tuscaloosa Stage, (b)Eutaw Stage, (c)Rotten Limestone Stage, (d)Ripley Stage. Rocky M't'ns (a)Commanche Stage, (b)Dakota Stage, (c)Benton Stage (d)Niobrara Stage, (e)Pierre Stage, (f)Fox Hills Stage, (g)Laramie Stage. Pacific Coast.(a)Shasta Stage, (b)Chico Stage, (c)Tejon.

CENOZOIC GROUP. XII,Tertiary System. A,Eocene or Alabama Series. Gulf States, (a)Claiborne Stage, (b)Jackson Stage, (c)Vicksburg Stage, Western States. (a)Puerco Stage, (b)Wahsatch Stage (c)Wind River Stage, (d)Bridger Stage, (e)Uinta Stage. B,Miocene or Yorktown Series, including perhaps the Sumter of the Atlantic Border. On the Pacific Slope, (a)White River Stage (b)John Day Stage, (c)Loup Fork Stage. C,Pliocene Series. (Of doubtful American determination). XIII,Quaternary System. A, Glacial Series, B,Champlain Series, C,Terrace Series, D,Recent Series.

Other terms are also often used, especially when we do not wish to speak too definitely. Formation is a word loosely employed for any of the above divisions. Terrane is used in much the same way but is rather more restricted to the lesser divisions. A stratum is one of the larger sheet like masses of sedimentary rocks of the same kind; a bed is a thinner subdivision of a stratum. Horizon is used to indicate a particular position in the geological column; thus speaking of the Marcellus Stage, we say shales of this horizon occur in central N. Y..

The rock species themselves are classified into three great groups, the Massive, the Sedimentary, and the Metamorphic.

The Massive (synonymous terms,igneous, eruptive, volcanic,plutonic), include all those which have solidified from a state of fusion. They are marked by three types of structure, the holocrys-

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talline , porphyritic and glassy , depending on the circumstances under which they have cooled . Under the first type of structure come the granites , syenites , diorites , gabbros , diabases and peridotites ; under the second , quartz-porphyries , rhyolites , porphyries , trachytes , porphyrites , andesites and basalt ; under the third , pitchstone , obsidian and other glasses . The sedimentary rocks are those which have been deposited in water. They consist chiefly of the fragments of preëxisting rocks or the remains of organisms . They include gravel , conglomerate , breccia , sandstone both argillaceous and calcareous , shales , clay limestone and coal. With these we usually place a few that have originated by the evaporation of solutions , as rock salt , gypsum etc.... The metamorphic rocks are altered , and usually crystallized members of the sedimentary series . They are all more or less crystalline , more or less distinctly bedded or laminated ; of ancient geological age or in disturbed districts . They include gneiss , crystalline schists , quartzite , slate , marble, serpentine . After a brief topographical survey we shall employ the above terms to summarize the geological structure of the U.S.. The several purely artificial territorial divisions are made simply for convenience . Nothing but intelligent travel will perfectly acquaint one with the topographical and geological structure of the country , and in this connection Mac Farlane's Geol. R.R.Guide , and a geological map are indispensable .

On the east we note the great chain of the Appalachians with a more or less strongly marked plain between it and the sea. This is especially marked in the south . It is of late geological age and contains the pine barrens and sea coast swamps.The Appalachians themselves consist of many ridges running on the north into the White Mountains, the Green Mountains and the Adirondacks. Further south the Highlands of N.Y. andN.J., the South Mountain of Penn, and the Alleghenies, the Blue Ridge and the other Southern chains , make up the eastern great continental ridge. In western New York and Ohio we find a rolling , hilly country , in Kentucky and Tennessee elevated table-land , in Indiana , Illinois , Iowa and Missouri prairie and rolling country , more broken in southern Mo. by the Ozarks. In Mich., Wis. and Minn. the country is rolling and hilly with numerous lakes. In Ark., La. and Miss. there are bottom-lands along the Mississippi and Gulf and low hills back in the interior. West of these states comes the great billowy prairie region, and then the chain of the Rocky M't'ns consisting of high dome-shaped peaks, with great elevated valleys between the ranges. Some distance east of the main chain are the Bl'k Hills (consisting of later concentric formations around a central older nucleus) and also the extinct volcanic district of the Yellowstone National Park. In western Col., Utah and N.M. between the Rocky M't'ns and the Wasatch, is the Colorado plateau, an elevated table-land. This is terminated by the north and south Wasatch range

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and west of this the region called the Great Basin, characterized by alkaline deserts, and subordinate north and south ranges of mountains. Next comes the chain of the Sierra Nevada, and lying between it and the Coast Range is the great north and south valley of California. This rises in the comparatively low Coast Range which slopes down to the Pacific Ocean. To the north, these M't'ns extend into eastern Oregon and Washington, with forests and fertil river valleys.

I. The New England, New York, New Jersey and Eastern Pen District. In New Eng. and northern N.Y. the Archaean is especially developed forming the White M't'ns. the Adirondacks, and the Highlands of N.Y. and N.J. They all consist of granite and other massive rocks, of gneiss and of crystalline schists. There are also great areas of metamorphic rocks whose true age may be later. The Green M't'ns. are formed of these. In New Eng. there are small scattered exposures of the undoubted Palaeozoic (Devonian, Carboniferous). In eastern N.Y. and to some extent in N.J. and eastern Penn. the entire Palaeozoic, except the Carboniferous, is strongly developed. Up and down the coast there are narrow north and south estuary deposits of red Jura-Trias sandstone pierced by diabase eruptions. The Cretaceous clays are strong in N.J. Tertiary strat occur at Marthas Vineyard. And over all as far south as Trenton is found the glacial drift. Between the Archaean ridges of the Highlands and the first foldings of the Palaeozoic on the west, is found the so called Great Valley which also runs to the south.

II. The Eastern, Middle and Southeastern Coast District. The low plains of the coast are formed by Quaternary, Tertiary and Cretaceous sand and clay. Inland there are exposures of Jura-Trias, as in the north. The Archa an crystalline rocks are also seen at numerous points not far from the ocean, Florid a is largel made up of coral limestone.

III. The Appalachian Region.

This Mountain system, extending from New York to Alabama, consists principally of folded Palaeozoic, with Archaean ridges on its eastern flank. There is an enormous development of folds with N.E. and S.W. axes and north extensions (See Fig. I.) On the west it is succeeded by the plateau region of Kentucky and Tennessee. Along central latitudes the Archaean does not again appear east of the Mississippi.

IV. The Region of the Great Lakes.

In Mich, Wis. and Minn. the Archaean rocks are extensively developed, both Laurentian and Huronian. Around Lake Superior are found the massive and sedimentary rocks of the Keweenian followed by the lower Palaeozoic. Lakes Mich. and Huron are surrounded by Silurian, Devonian and Carboniferous. Lake Erie by Devonian; Lake Ontario by Silurian. Running south through Ohio we find an important fold known as the Cincinnati uplift, with a north and south axis, this was elevated at the close of the Lower Silurian. In the lower peninsular of Mich. in eastern Ohio and western Penn. the Carboniferous is extensively developed.

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V. The Mississippi Valley.

The head waters are in the Archaean . It then passes over Cambria and Silurian in Minn and Wis, northern Iowa and Ill. These are succeeded by subordinate Devonian and in southern Iowa, Ill and Mo. Carboniferous. In southern Mo. Lower Silurian forms the west bank. Thence to theGulf the river flows on estuary deposits of Quaternary age with Tertiary and Cretaceous further inland.

VI. The Gulf Region.

The Gulf states along the water are formed by the Quaternary. This is soon succeeded inland by very extensive Tertiary which is the principle formation represented.

VII. The Prairie District.

West of the Palaeozoic rocks of the states bordering on the Mississippi is found a great strip of Cretaceous running from the Gul to British America, and bounded on the west by the foothills of the Rocky Mountains. A few Tertiary lake deposits are found in it Quite extensive Triassic rocks are developed on the south . The surface is a gradually rising plateau to the Rocky M't'ns.

VIII. The Region of the Rocky M't'ns., the Black Hills and the National Park.

The Rockies rise from the Prairies in long north and south ranges consisting of Archaean axes with Palaeozoic in relatively small amount and abundant Mesozoic on the east and west flanks. In the Parks are found lake deposits of Tertiary age . There are also great bodies of massive rocks which attendthe various upheavals. The outlying Black Hills consist of an elliptical Archaean core with concentric Palaeozoic and Mesozoic rocks laid up around it . The National Park consists chiefly of massive (volcanic) rocks in enormous development .

IX. The Colorado Plateau.

The Rocky M't'ns shadecut on the west into a great elevated plateau extending to central Utah where it is cut off by the nort and south chain of the Wahsatch. The Uintah M't'ns are an east and west chain in it . The rocks on the north chiefly Tertiary with Mesozoic and Palaeozoic in the Mountains. To the south are found Cretaceous and Triassic strata with massive rocks of great extent.

X. The Region of the Great Basin.

Between the Wahsatch and the Sierra Nevada is found the Great Bas region, once a lake bottom, now very largely an alkaline plain of Quaternary age. The surface is broken by subordinate north and south ranges, largely formed by great outflows of eruptive rocks with some Palaeozoic.

XI. The Region of the Pacific Slope.

On the West the Sierras slope down into the great central valley of California. The flanks are largly metamorphosed Jurassic and Cretaceous rocks with a great development of massive outflows. The valley rises again in the Coast range, which slopes away

further west to the Ocean. In addition to the Jurassic and Cretaceous the Tertiary and Quaternary are also developed.

XII. The Region of the Northwest.

Washington and Oregon along the coast are formed by Cretaceous and Tertiary strata similar to California. But inland immense outpourings of eruptive rocks cover the greater portion of both states and extend into Idaho. On the north the Carboniferous is extensive running eastward into Montana. Quaternary and Tertiary lake deposits are also not lacking.

On the Forms assumed by Rock Masses.

All sedimentary rocks were formed originally in approximately horizontal beds. We find them now, however, in almost all cases, changed from a horizontal position, by movements caused primarily by the contraction of the earth's crust. They then assume folds known as monoclines, anticlines and synclines; affording the phenomena of dip and strike. (Views and sections), Massive rocks are in the form of sheets, knobs or bosses, laccolites and dikes. (Views and sections.)

On the Results of rock movements, and the Formation of Cavities. In cooling or drying and hardening, both massive and sedimentary rocks break into more or less regular masses along divisional planes called joints occasioning numerous cracks, and in this way forming small cavities. (Illustrations). Then in the course of folding the rocks are strained beyond their limit of resistance they often part and slip past each other in long cracks known as faults from the non-conformability of the parts on each side. When inclined to the horizon, the dip of a fault is called its hade, and the rocks usually slip down on the dip (i.e. hade to the down throw). Less often they rise as if pressed together on the hade affording what is called a reversed fault (Illustrations). The rubbed sides exhibit slips or schlick naides. In this way cavities known as fissures are formed. The slipping past each other of corrugated surfaces gives rise to swells and pinches in a fissure (Illustrations).

The subterranean circulation of water also forms cavities especially in limestone rocks. The same agent may serve to enlarge joints and fissures. By the action of water carrying magnesia in solution upon calcareous rocks a portion of the lime in the carbonate of lime molecule is replaced by magnesia, by the process called dolomitization. There is then an attendant shrinkage which also forms cavities. A rock (and especially limestone) may be entirely replaced by minerals brought in solution by the water circulating through it. The exchange is effected molecule by molecule, and is spoken of as a metasomatic interchange or replacement. Bodies of minerals so formed may afterwards undergo alteration and occasion cavities by their consequent shrinkage.

On the Grouping of Minerals Important in this Connection the minerals that enter into ore deposits may be divided into two

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classes, ore minerals and gangue minerals. The first class includes those that are useful and valuable, the second those that are worthless, and that must be separated from the first. The chemical compounds forming the first class are very largely sulphides and oxides, also in far less amounts arsenides, carbonates, silicates, sulphates, phosphates, and chlorides. The gangue minerals are comparatively few, including as the commonest quartz, calcite, siderite, barite and fluorite. The ores of each metal will be spoken of under the metal itself. The original sulphides, oxides etc., when exposed to atmospheric agents tend to form alteration products, chiefly due to oxidation or hydration; Sulphides etc. change to sulphates, carbonates, oxides, hydrousoxides etc., and these latter are called oxidized ores. In almost every ore deposit, the portion lying above the line of permanent water level consists of these alteration products or oxidized ores, and these in depth, as the line of permanent water level is passed, graduate into unchanged sulphides; hence the term, zone of oxidized ores, zone of sulphurets. The decomposed outcrop of a mineral vein, usually has a rusty color, from the amount of iron stains in it, and is called the iron hat or gossan. The change in the character of the ores in depth is an important thing in mining as it may occasion great alteration in value, and in methods of treatment. Many veins possess a marked banded structure, due to the successive deposit of different minerals which may correspond layer for layer on each wall. When the two sides come together the opposite rows of crystals may project into each other, causing what is called a comb structure. Not infrequently as a vein cuts two different kinds of rock the the mineral character changes with the walls, affording two different kinds of ores, or it may be, valuable and worthless material. Between the filling of the vein and the walls of the fissure, there is often a layer of clay, which is called a selvage or gauge; the same is also found along lines of parting, perhaps of attrition in the vein itself. Masses of the barren wall rock are often found enclosed in a vein, and these are called horses. In fissure veins they have been caused by a movement of the walls after the vein was partly filled. A portion of the wall has then been broken off and become buried in the vein matter itself.

On Theories of Origin. (See v.Cotta).

I. Contemporaneous Formation (i.e. with the walls). Stahl(1700). Zimmermann (1746). Charpentier (1778). v.Terebra (1785).

II. Lateral Sections. Delius (1770). Gerhard (1781). Lasins (1789). Sandberger

III. Descension. Baumer (1779(. Werner (1791(.

IV. Ascension by (a) infiltration. Lasius (1789(. (b)sublimation with steam. Lehmann (1753). (c) sublimation as gas. Becher (1703). (d) igneous injection. Hutton (1790).

V. Replacement. Posepny (1873). Pumpelly (1873). Curtis (1884). Emmons (1886). Irving (1886).

Galvanic action of an electrolytic character was early suspected to be an important precipitating agent (Fox and others circa 1830 Barus), but the best experiments have as yet been inconclusive.

On the Necessary Limitations in all Schemes of Classification. All attempts at classification are based upon two fundamental principles, shape and origin. It is readily seen that all the earlier classifications attach too much importance to mere shape. Mineral deposits vary much in form, and that should not be unduly emphasized. The other principle, that of origin, is none too well understood, and while at the present time we know vastly more of the history of many ore bodies than has ever been the case before, it is unwise to apply too hastily the results reached in one region to phenomena not yet thoroughly studied in another. It would perhaps bring out the relations of ore bodies best if we were to group together those of like structure, and mineral contents, as has been done by von Graddeck, but so much in the way of convenience is sacrificed by separating deposits worked for individual metals, that the metals themselves will be made the primary basis of the classification here adopted. But emphasis is here laid on the fact that on account of the great diversity the principles must be elastically applied. The principal schemes hitherto formulated are appended, in order to give a view of what has been previously done.

J.D.Whitney 1854 Metallic Wealth. U.S. p.54	v.Cotta 1859. Erzlagerstätten	Grimm 1869.	Lottner Translated by Raymond.Mineral Resources 1870p447
I.Superficial.	I.Regular Deposits.	I.Essential Component Minerals and Inclusions in country rock.	I.Superficial.
II.Stratified.	A. Beds.		(a) Debris.
(a) Entire beds or strata.	B.Veins.		(b) Surface formations in place.
(b)Disseminated through beds.	(a) True fissure veins.	(a)Original with the enclosing rock.	II.Enclosed Deposits.
(c) Deposited from solution but later metamorphosed.	(b)Bedded veins.	(b) Fragments brought from a distance.	A.Sheet or Tabular deposits.
III Unstratified	(c) Contact veins.	1.Placers.	(a) Lodes.
A.Irregular.	(d)Lenticular veins.	2.Ore bearing boulders, breccias.	(b)Beds and seams.
(a) Eruptive Masses.	II.Irregular Deposits.	II.Deposits individual and distinct from the country rocks.	B.Mass Deposits.
(b)Disseminated in eruptive Rocks	A.Segregations Recumbent and Vertical also		(a) Masses.
(c) Stockworks.	(a) Floors.		(b)Impregnations.
(d) Contact Deposits	(b) Contact Masses.	(a) Tabular Masses.	C.Other irregular Deposits.
(e) Fahlbands.	(c) Cavity Fillings.	1.Beds.	(a) Pockets distributed in other deposits.
B. Regular.	B.Impregnations (Disseminations).	2.Veins.	(b) Isolated aggregations.
(f)Segregated.			Gash veins etc.,

J.D.Whitney.continued.
.veins.
(c).Gash veins.
(h)Fissure veins
or True veins.

Grimm.continued.
3.Sheetshaped
Segregations.
(b) Irregular
Masses.
1. Interbedded.
2.Not interbedded.
3.Reticulated Veins.

v.Groddeck/1879? Newberry.1880 & 1884.
I.PrimaryDeposits.
A.Stratified: Contemporaneous with walls.
(a) Surface.
(b)Interstratified.
B. Massive.
Later than walls.
C.Cavity fillings
(a) Fissures.
(b) Caves.
D.Metamorphic Deposits.
II.Secondary or Detrital Deposits.

A.Superficial.
B.Stratified
(a)Entire Strata.
(b)Disseminated through Strata.
(c)Segregated from Strata.
C.Unstratified.
(a) Eruptive Masses.
(b)Disseminated through Eruptive Rocks.
(c) Contact deposits.
(d)Stockwerks.
(e) Fahlbands.
(f)Impregnations
(g)Chambers.
(h) Mineral Veins.
1.Gash Veins.
2. Segregated Veins.
3.Fissure Veins.
4.Bedded veins.

Pumpelly.1886.
I.Forms due to the texture of the enclosing rock,or to its Mineral constitution or to both causes.
A.Disseminated Concentration.
(a)Impregnations
(b)Fahlbands.
B.Aggregated Concentrations.
(a)Lenticular Aggregations and beds.
(b) Irregular Masses.
(c) Reticulated veins.
(d)Contact Deposits.
II.Forms chiefly due to preexisting open Cavities or fissures.
C.Cave Deposits
D.Gash Veins.
E.Fissure Veins
F.Surface Deposits etc..
(a) Residuary deposits.
(b)Stream Deposits.
(c)Lake or Bog Deposits.

Phillips.1884.
I.Superficial.
(a)Deposits formed by the mechanical action of water.
(b)do.do.by chemical action.
II.Stratified.
(a)Deposits constituting the bulk of metalliferous beds p'p'ted from aqueous Solution.
(b)Beds originally deposited from solution,but later metamorphosed.
(c)Ores disseminated through sed beds in which the have been chem. deposited.
III.Unstratified
(a) True Veins.
(b)Segregated veins.
(c).Gash Veins.
(d)Impregnations.
(e) Stockwerks.
(f)Fahlbands.
(g)Contact deposits.
(h) Chambers or pockets.

The terms ''lode''and ''ledge''are used as synonyms of vein, and ''seam''is a synonym of bed.

I.D. Mining, continued.

Veins.

(a) Lode Veins.

(b) Placer Veins.

or Lode Veins.

Primary Deposits. & 1884.

A. Superficial.

B. Stratified.

(a) Drift.

Strata.

(b) Disconformable.

Inclined through.

Strata.

(c) Segregated.

Veins.

(a) Fissure Veins.

(b) Contact.

(c) Bedded.

(d) Stockworks.

(e) Pockets.

(f) Impregnations

(g) Chambers

(h) Linear

Veins.

1. Open Veins.

2. Segregated

Veins.

3. Placers.

4. Bedded veins.

Primary continued.

1. Sheeted

Segregations.

(b) Irregular

Masses.

1. Interbedded.

2. Not interbedded.

3. Reticulated Veins.

Pumpelly, 1884. Pre-Alpine 1884.

I. Forms due to I. Superficial.

the texture of (a) Deposits formed

the enclosing by the mechanical

rock, or to its action of water.

Mineral constitu- (b) do. do. by chem.

tution or to ical action.

both causes. II. Stratified.

A. Diagenesis. (a) Deposits con-

Concentration. sisting the

(a) Impregnations bulk of metal-

(b) Pockets. liferous beds

B. Aggregated p'p'ed Iron

Concentrations. equitous Solution

(a) Bertiular (b) Beds original

Aggregations ly deposited from

and beds. solution, but las

(b) Irregular metamorphosed.

Masses. (b) Ores disseminated

(c) Reticulated mated through ad

veins. beds in which th

(d) Contact have been chem.

Deposits. Deposited.

II. Forms chiefly III. Uncertain

due to preexist (a) True Veins.

ing open Cavi- (b) Segregated

ties or fissures, veins.

c. Bedded Deposits (c) Open Veins.

D. Mass Veins. (d) Impregnations

E. Fissure Veins (e) Stockworks.

F. Surface (f) Pockets

Deposits etc. (g) Contact depo

(a) Residual its.

deposits. (h) Chambers or

(b) Stream Deposits. pockets.

(c) Lake or Sea

Deposits.

The terms 'lode' and 'lodes' are used as synonyms of vein,

and 'seam' is a synonym of bed.

Discussion of the Schemes, and Remarks on their comparative Merits
From a comparison of the above it will be seen that J.D.Whitney's classification contains the essentials of the others published in English, and this with the modifications introduced by Newberry will supply the phraseology for these notes. In addition much emphasis will be placed on the character of the rocks containing the deposit whether unaltered sedimentary, massive, or metamorphic and whether or not there are eruptive rocks in the vicinity, as these considerations enter most largely into any explanations of origin. The ore deposits will however be illustrated by types and thus greater ddefiniteness introduced following the example of one of the best of modern writers v.Groddeck.

Under each metal will be givern first a group of references to general treatises and papers. These will be marked Hist. when especialy valuable as history, and Rec. when recomended for consultation. If not marked by either they are valuable for special investigations.

The Iron Series.

Limonite, Siderite, Hematite, Magnetite,
(Cf. Any good Mineralogy), The Iron Minerals.

		Fe.	H_2O.	CO_2.	S
Limonite-(Brown Hematite, Bog Iron Ores.)	$2Fe_2O_3 3H_2O$	59.92	14.4		
Siderite-(Spathic Iron, Clay Iron Stone Black band)	$FeCO_3$	48.3		37.9	
Hematite-(Red and Specular).	Fe_2O_3	70.			
Magnetite.	$FeO\ Fe_2O_3$	72.4			
Native Iron-Meteorites.					
Pyrites	FeS_2	46.7		53.	

General remarks on the ores. Universal presence of iron. Circulation in solution as protoxide, precipitation as hydrated sesqui-oxide.

General Literature.

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Chester A.H. On the Percentage of Iron in Certain Ores. M.E. IV. 219 Re

Hoefer Hans. Die Kohlen und Eisenerzlagerstätten Nord-Amerikas. Vienna. 1878. Rec.

Julien A.A. Genesis of the Crystalline Iron Ores. Proc. Phila. Acad Sci. 1882. p. 335. Rec.

Lesley J.P. The Iron Manufacturer's Guide 1866. Hist. Rec.

Newberry J.S. International Review. Nov. Dec. 1874.

Genesis of the Ores of Iron. S. of M. Quarterly. Nov. 1880. Rec.

Genesis of the Crystalline Iron Ores. Trans. N.Y. Acad. Sci. Vol. II. Oct 1882.

Newton. H. The Ores of Iron. Their Geographical Distribution etc. M.E. Vol III. p 360.

Pumpelly. R. and others, Tenth Census U.S. Vol XV. 1886. Rec. especially pp. 3-17.

Rammelsberg. On the constitution of the Titaniferous Iron Ores. Pogg. Ann. CIV 497. A.J.S. II. 27.127 & 423.

Smock. J.C. On the Geological Distribution of the Ores of Iron. M.E XII. 130.
Iron Mines and Iron Ore. Dist. in N.Y.
Bull. 7. N.Y. State Museum. June 1889. Rec.
Whitney J.D. Metallic Wealth U.S. 1854 p425. Dist.
On the Occurrence of the Ores of Iron in the Azoic System. A.J.S. II Vol. 22. p.38.
Williams A. and since 1885. Day. D.F. Mineral Resources of the U.S Annual of the U.S. Geol. Survey. Rec.

Limonite.

Type 1. Bog Ore. Beds of Limonite under swamps and marshes. In circulating in running water as $FeOCO_4$ is brought to rest in the standing water of bogs. It is here oxidized to the insoluble hydrated sesquioxide ($Fe_2O_3.xH_2O$) sinks to the bottom and accumulates as cellular masses of limonite, Such deposits are of very wide distribution, but not often of value on account of their impurities. In the vicinity of Puget Sound they are however numerous and have been utilized.

Type 1.a. Staten Island. Deposits of Limonite in the superficial hollows of serpentine rocks on Staten Island. They are thought by Dr. N.L. Britton to have been leached out of the serpentine, and deposited in situ. They carry considerable Cr_2O_3. They have been quite extensively worked in former years.
Britton N.L. S of M. Quarterly May 1881.

Type 1.b. Prosser Mines near Portland Oregon. Deposits of Limonite in the superficial hollows of basalt, of Tertiary age, in the Cascade Range. The ore contains roots and trunks of trees, and is covered by another flow of basalt. The Patton Mines are near by and are formed of the usual surface bog ore.
Putnam. B.T. Tenth Census XV 496 & 16.
Limonites apparently surface deposits are also worked quite extensively in Cherokee Co. Northeastern Tex. They are known also in L Mineral Resources. 1887. p.51.

Type 2. Bodies of limonite in cavities of ferruginous rocks on the outcrop or below the surface; which have resulted from the alteration of the rock in situ. Residual clay, quartz and other remains of alteration usually occur with the ore. Ferruginous limestones are the commonest sources of such deposits but other rocks may afford them. The deposits are not limited to any one geological series but in different parts of the country occur whenever the conditions have been favorable. Considerable limonite has also resulted from the weathering of clay-ironstone nodules, and black-band beds in the Carboniferous to be mentioned later, and not infrequently from the alteration of nodular masses of pyrite.

The second and third magnesian limestones of the Lower Siluria System in Southern Mo. have numerous cavities filled with stalactitic limonite, and at Hot Springs, Saguache Co. Col., great deposits occur in cavities in limestones supposed by Rolker to be Silu

Emmons, W.H. On the Geological Distribution of the Ores of Iron. N.Y. Acad. Sci. Ann. XII. 139.

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(Bull). N.Y.State Museum. June 1899. Rep.

Williams, J.F. The Clinton Iron Ores. U.S. Geol. Surv. Ann. Rep. XVI. 1894 pp2a-44a.

On the Occurrence of the Ores of Iron in the Arkansaw System. A.I.M.E. 19 Vol. 22. p.58.

Williams A. and others 1885. Dep.M.T. Mineral Resources of the U.S. Annual of the U.S. Geol. Survey. Rep.

Limonite.

Type I. Bog Ore. Beds of Limonite under swamps and marshes. Formulating in running water as Fe_2O_3 is brought to rest in the standing water of bogs. It is here oxidized to the insoluble hydrated sesquioxide ($Fe_2O_3.xH_2O$) sinks to the bottom and accumulates as colluvial mass as of limonite. Such deposits are of very wide distribution, but not often of vein on account of their impurities. In the vicinity of Puget Sound they are however numerous and have been utilized.

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Britton N.L. S of N. Quarterly May 1891.

Type I.b. Prosser Mines near Portland Oregon. Deposits of Limonite in the superficial hollows of basalt, of Tertiary age, in the Cascade Range. The ore contains rocks and trunks of trees, and is covered by another flow of basalt. The Patton Mines are near and are formed of the usual surface bog ore.

Putnam.H.T. Tenth Census Vol 15. p.

Limonites apparently surface deposits are also worked quite extensively in Ohio, e.g. Northeastern Tex. They are known also in Mineral Resources. 1897.p.81.

Type 2. Bodies of limonite in cavities of ferruginous rocks of the outcrop or below the surface, which have resulted from the alteration of the rock in situ. Residual clay, quartz and other remains of alteration usually occur with the ore. Ferruginous limestones and the commonest source of such deposits but other rocks may afford them. The deposits are not limited to any one geological series but in different parts of the country occur where the conditions have been favorable. Considerable limonite has also resulted from the weathering of clay-ironstone nodules, and black band beds in the Carbonif rous to be mentioned later, and not infrequently from the alteration of nodular masses of pyrite.

The second and third mesozoic limestones of the Lower Silurian System in Southern Mo. have numerous cavities filled with stalactites limonite, and at Hot Springs, Saguache Co. Col., great deposits occur in cavities in limestones capped by Potsdam so be 81

rian. The Oriskany in Penn. affords some silicious limonite but in Va. the strata enclose great quantities; at Low Moor and Longdale the ore reaches a thickness of 40'. In Perry Co. Penn. the shales of the Hamilton Series carry quite extensive limonite beds. The Subcarboniferous limestones of Western Ky. and Tenn. contain great quantities of limonite as pots, strings and pipe ore in residual clay which has resulted from the weathering of limestone. In Mo. on the Upper Osage Riv. is also an extensive bed in rocks of this same series. In Colorado some of the Leadville limonites in the Subcarboniferous are used as iron ore, although of different origin, and similar limonites occur in the East Tintec Mining Dist. Utah in supposed Carboniferous. The buhrstone ore of Laurence Co. Penn. fills cavities in Carboniferous limestone.

Boyd.C.R. The Ores of Cripple Creek Va. M.E. 12. 27. 1884.
Resources of S.W.Va. N.Y. 1891
Rowees.J.H. 2nd Geol. Surv. Penn. Report. F. 1878.
Lyman B. Geol. of the Low Moor Va. Iron Ores. M.E. 14.807
McCreeth A.S. The Iron Ores of the Valley of Va. M.E.12.27.1884
Moor P.N. Mo. Geol. Surv. 1874
Rolker C.F. Notes on Certain Iron Ore Deposits in Col. M.E. 14.366
Endlich F.M. Haydens Rept. 1873.p. 35.In the Sangre de Cristo Mtns
Putnam D.F. 10th Census Vol.15.p.482 On Col. limonites.

— Type 2a. Siluro-Cambrian Limonites. Beds of limonite in so called hydromica (talcose) slates and schists belonging to the Cambrian and Lower Silurian Systems. The masses of limonite are buried in ochreous clay and the whole preserves the general structure of the schistose rocks which they have replaced. The original stringers of quartz remain following the original folds. Occasionally dolomitic limestone forms one of the walls, and still less often masses of siderite are found enclosed. The deposits extend from Vt southward along the line of N.Y. and New England, and are extensively developed in Lehigh Co. Penn. They are not as abundant in Va. but in eastern Tenn. in the Knox Stage of the local geologists they are extensive; but here limestones replace the hydromica schists of the north and the deposits are more like the principal type. The ore uniformily occurs west of the Archaean ridges and in the trough (the so called Great Valley see p.4.) between them and the more westerly corrugations of the Palaeozoic. The Cornwall magnetite (see below Type 13c.) is thought by Lesley to be an altered limonite bed of this character, which has been changed to magnetite by the neighboring Triassic traps.

As regards the origin of these deposits Dr. Jackson of the first Penn. Survey, argued in 1839 their origin in situ. Percival in the Rept. on Geol. of Conn. p.132 attributed them to pyrite in the neighboring mica slate. Prime in Penn. in 1875 and 1878, derives the iron by leaching from the neighboring dolomites and slates, it being in them either as silicate carbonate or sulphide. Fraser(1876) traces them to original pyrite in the slate. J.D.Dana in NewEngland

(1877) attributes them to the weathering of ferruginous limestones which they replace. For New England this is probably correct. Much that is purely imaginative has been written by others regarding them, since DR. Hitchcock from some associated fossils in Vermont referred them all to the Tertiary times, and others derived them from the drainage of Archaean Highlands in Silurian & Cambrian times.

Extensive deposits of related character occur in the Huronian schists Beds X. and XII of Brook near Negaunee Mich. where they are called soft hematites.

Dana J.D. Occurrence &Origin N.Y.&N.E.Limonites A.J.S.1877.p135 Rec
Fraser P. Penn. 2nd Geol. Surv. Rep. C. (1876).
Harden J.W. Br. Hem. Dep. of S. M't'n etc M.E. 1.136.
Hitchcock E.On the Brandon Lignite etc. also Geol. of Vt. Vol.I. p. 233. A.J.S. II. 15. 95.
HollyA.L. Notes on the Salisbury Iron Mines & W'ks. M.E. 3.230
Lesley J.P. On Mont Alto Penn etc. Proc.Am. Acad.Sci.1864.463-482.
Lewis J.F. The Hem.(Br).Ores,Mines etc. E.of the Hudson R.M.E.5.216
Lyman B.F. On the Lower Sil.Br.Hem.Beds of America.A.A.A.S.17.114.
Percival J.G. Rept. on Geol. Conn.p.132
Prime F. On the Occurrence of the Br.Hem.Dep.of the Great Valley M.E. 3.410 Rec. Also Penn. 2nd Survey. Repts. D(1875) & D.D. (1878).
Rogers H.D. Trans. Ass.Am. Geol.& Nat. 1842. p.345.

Analyses of Limonites.

	Fe	P	S	SiO_2	Al_2O_3	H_2O.
Berkshire County, Mass.	47.52	0.187				
Connecticut	50.48	0.353				
Staten Island	39.72	0.059	0.391	14.19	3.59	13.41
Pennsylvania	56.3	0.125	0.02	5.135		
Virginia(Low Moor)	43.84	0.636				
Tennessee (Lagrange Furnace)	50.91	0.237				
Alabama	50.39	0.325				
Colorado	53.37	0.034	0.20	7.90	0.70	
Prosser Mine,Oregon.	44.71	0.636				
Pure Mineral	59.92					14.4

Siderite or Spathic Ore.

When of concretionary structure in shales, , and containing much clayey matter, these ores are called clayironstone; when forming beds of limited extent in the coal measures and having much bituminous matter they are called black-band.

Type 3. Burden Mine, near Hudson N.Y..Beds of spathic ore, enclosed conformably between underlying slates and overlying sandstones of the Hudson River Stage. The beds vary up to 40' in thickness and consist of gray or drab massive siderite with associated calcite and pyrite. The ore is known to outcrop over a distance of four miles, but is not uniformily good. Much of it however is pure enough for Bessemer Steel. The total output is estimated at 450000 tons. Somewhat similar ores are known in the Marcellus Shales in

(1877) attributes a th m to th, weathering of ferruginous limestone
Wmtsh th Y region, New England this is probably correct. Most
thor is pub ly imaginative has been written by others regarding
thom, since PR, Wyckoff from some associated fossils in Vermont
referred them all to the T rtiary times, and others derived th m
from the drainage of Arkansan Highlands in Silurian-Cambrian times.
Extensive deposits of related interest occur in the Hurontian
sediments Redw X, and XII of Brook near Negaunee Mich. where they
are called both Jamestown.

Dana J.D. Occurrence Gold in N.Y.,N.H. Limonites. A.J.S.,1877.pp.35 R
Trelease P. Perm. 2nd Geol. Surv. Rep. O. (1876).
Hardon J.W. Bk. Hum. Dep. of E. Mich'n Sta H.E. 1.136.
Hitchcock R. On the Brandon Limonite. Also Geol. of Vt. Vol.I. p
735. A.J.S. XI. 15, 95.
Holl Va.L. Notes on the Saltsbury Iron Mines & Works. M.E. 3.230
Ingalls J.D. On Ore Deposits etc. Proc.Am. Acad.Sci.1864.403-407
Lesley J.P. On Allo Penn etc. Trans.Am. Inst. Min.E.6.
Lesley J.P. On the Geography of the Br.Hum.Dep.of the Mississippi
Lyman B.F. On the Low Sil.Br.Hum.Beds of America.A.A.A.S.17.114
Prosser C.S. On the Geography of the Br.Hum.Dep.of the Vall.
Prime F. On the Occurrence of the Br.Hum.Dep.of the Vall.
M.S. 3.610 Rec. Also Penn. 2nd Survey. Repts. D(1875) &
D.D.(1877).
Rogers H.D. Trans. Am. Geol.& Nat. 1842. p.845.

Analyses of Limonite.

Fe.	P	S	SiO_2	Al_2O_3	H_2O
			14.52	0.127	
			50.68	0.305	
			39.72	0.055	0.891
			58.5	0.185	0.02
			43.34	0.250	
			50.71	0.337	
			50.05	0.125	
			53.07	0.034	0.20
			44.71	0.321	
			59.02		

Siderite or Spathic Ore.

Ores of comparatively recent age, and containing much clayey matter, these ores are called clayironstone; when found in beds of limited extent in the coal measures and having much bituminous matter, they are called blackband.

Type 3. Dundon Mine, near Hudson N.Y. Beds of spathic ore, closed conformably between underlying slates and overlying sandstones of the Hudson River Stage. The beds vary up to 40' in thickness and consist of grey or drab massive siderite with associated calcite and pyrite. The ore is known to outcrop over a distance of four miles, but is not uniformly good. Much of it however is good enough for Bessemer steel. The total output is estimated at 450,000 tons. Somewhat similar ores are known in the Taconic Shales in

Ulster Co. across the Hudson River, and the presence of spathic ore with the limonite to the east (Cf. Type 2a) has already been noted.

Raymond R.W.The Spathic Iron Ores of the Hudson River.M.E.4.339.
Olmstead L. Distribution of Phosphorus in the Hudson River Carbonates. M.E. 1889.
Smock J.C. Bull.7.N.Y.State Museum pp. 62-65. Rec.

Type 4..Roxbury Conn. A fissure vein in gneiss,3' to 8' wide of siderite with which are associated quartz and a great variety of minerals, galena, chalcopyrite, blende, etc. Although productive in former years it is now no longer worked and is of scientific rather than economic interest. It is a unique deposit.

Shepard C.U. Report on the Geology of Conn. 1837. p.30. Also A.J.S. I. 19. 311.

Type 5. Clayironstone. Isolated masses of concretionary origin which at times coalesce to form beds of considerable extent. When in isolated masses they are distributed throuhg shales and on the weathering of the matrix are exposed and concentrated. They are especially characteristic of the Carboniferous strata and differ from black band only in the absence of bituminous matter, and in the consequent drab color. They weather easily to limonite generally in concentric shells with a core of unchanged carbonate within. Fossil leaves or shells often furnish the nucleus for the original segregation and are thus as at Mazon Creek Ill. beautifully preserved. When in sheets the ore is sometimes called flagstone ore; When broken into rectangular masses by joints it is called black ore. In western Penn. and in Ohio the ore is of the greatest importance. In W.Va. in the Subcarboniferous is found a bed said by W.B. Rogers (R.C.) to extend 30 miles, often from 3'-5' thick. It is also known in Maryland in Cretaceous clays, and in the Laramie Stage of the western states, the shales associated with the coal often contain it. A large bed has been reported in the Claiborne Strata of Enterprise Miss. The ores are calcined before being smelted.

Type 5a. Black band. Beds consisting chiefly of carbonate of iron with more or less earthy and bituminous matter. They are of varying thickness, though rarely more than 6' and are almost limited to strata associated with coal seams. They are thus especially found in strata of the Carboniferous System and to a far less degree in the Eastern Jura-Trias.(Va.N.C.). They are also recorded with the Cretaceous Coals of the west (Col.). These deposits are especially developed in Ohio, W.Va., Ky., and Ala., They and Type 5. are the chief sources for local ores in Ohio and are assigned by Orton to 11 different horizons.

Brainard A.F. Spathic Ore at Enterprise Miss. M.E. 16. 146.
McCalley.H.Geol.Surv. of Ala. Rept. on the Warrior Coal Field 1886 p.14 and elsewhere.
Orton Edw. Ohio.Geol.Survey Econ. Geol. Vols V and VI.
Platt.F. Fayette Co. Penn. 2nd Geol.Survey Rep.L. 1876.
Platt.W.G. Armstrong Co. Penn. 2nd Geol.Survey Rep.H 5. 1880.

Ulster Co. across the Hudson River, and the presence of spathic ore with the limonite to the east (Cf. Type 2a) has already been noted. Cayuga R.W. The Spathic Iron Ores of the Hudson River M.E. 4. 1859.
Olmstead L: Distribution of Phosphorus in the Hudson River Devonian ores. M.E. 1866.
Smock J.C. Bull.N.Y.State Museum pp. 82-85. Rec.
Type 4. Roxbury Conn. A fissure vein in gneiss, 3' to 8' wide of siderite with which are associated quartz and a great variety of minerals, galena, chalcopyrite, blende, pyr. Although productive in former years it is now no longer worked and is of scientific rather than economic interest. It is a unique deposit.
Shepard C.U. Report on the Geology of Conn. 1837. p.30. Also A.J.S. I. 19. 311.
Type 5. Olayironatone. Isolated mas es of concretionary origin which at times coalesce to form beds of considerable extent. When in isolated masses they are distributed through shales and on the weathering of the matrix are exposed and concentrated. They are especially characteristic of the Carboniferous strata and differ from black band only in the absence of bituminous matter, and in the consequent drab color. They weather easily to limonite generally in concentric shells with a core of unchanged carbonate within. Fossil leaves of shells often furnish the nucleus for the original aggregation and are when as at Mazon Creek Ill. beautifully preserved. When in sheets the ore is sometimes called flagstone ore. When broken into rectangular masses by joints it is called block ore. In western Penn. and in Ohio the ore is of the greatest importance. In W.Va. in the Carboniferous is found a bed said by W.B. Rogers (I.c.) to extend 30 miles, often from 3-5' thick. It is also known in Maryland in Cretaceous clays, and in the Jurassic Stage of the western states, the shales associated with the coal often contain it. A large bed has been reported in the Dakotas. Stratta of Montpelier Vt. The ores are calcined before being smelted.
Type 6a. Black band. Lean coaly shale containing spathic ore with more or less earthy and bituminous matter. They are of very variable thickness, though rarely more than 6' and are almost limited to strata associated with coal seams. They are thus associated found in strata of the Carboniferous System and to a far less degree in the Eastern Jura-Trias. (Va. N.C.). They are also recorded with the Cretaceous Coals of the West (Cod). These deposits are developed in Ohio, W.Va., Ky., and Ala., They and Type 5. are the chief sources for local ores in Ohio and are assigned Orton to it different horizons.
Brainard A.F. Spathic Ore at Enterprise Miss. M.E. 16. 142.
McCalley.H.Geol.Surv. of Ala. Repts on the Warrior Coal Field 1886 p.14 and elsewhere.
Orton Edw. Ohio Geol.Survey Rep. Geol. Vols V and VI.
Platt.F. Fayette Co. Penn. 2nd Geol.Survey Rep.I. 1876.
Platt.W.G. Armstrong Co. Penn. 2nd Geol.survey Rep.H 5. 1876.

Rogers W.B. The Geology of the Virginias 1884. 105-108 & elsewhere
Sharpless S.P. Notes on the Black-band Iron Ores of W. Va. M.E.10.

Analyses of Spathic Ores.

	Fe	CO_2	P	S	SiO_2	Al_2O_3	H_2O
Burden Mine N.Y. (Calcined)	49.6		0.390	0.58	11.03	26.37	
Ohio Black-band.	27.3		0.043	0.17	25.52	0.50	
England (Clay ironstone).	31.42	22.0	0.47	0.14	10.36	5.92	4.45
Scotch Black-band	32.0	32.0		0.50	8.00	5.00	0.50
Pure Mineral	48.3	37.9					

Hematite, Red and Specular.

The sesquioxide of Iron Fe_2O_3 is always of a red color when in powder, if of earthy texture this color shows in the mass and the ore is called red hematite; if crystallized the red color is not apparent and the brilliant luster of the mineral gives it the name specular. The red hematites are first treated.

Type 6.. Clinton Ore. One or more beds of red hematite interstratified with shales and limestones of the Clinton Stage. They are of extraordinary persistence, as they outcrop in Wis. Ohio and Ky., in the interior; and then begining in N.Y. south of Lake Ontario, they run easterly across the state. Again in Penn. they follow the waves of the Appalachian folds and run south in W.Va. and Va. in great strength. Again they are found in Tenn. and Northwestern Ga. and finally in Ala. are of unusual thickness and economic importance. The structure of the ore varies somewhat, being in places the replacement of fossils, such as crinoid stems, mollusca shells etc.(fossil ore). Again as small nodular concretions like flaxseed (flaxseed ore, lenticular ore), and elsewhere it is known as dyestone ore. The ore is really a highly ferruginous limestone and below the water level in the unweathered portions passes often into limestone, but along the outcrop it is quite rich. In Dodge Co. Wis. the ore is 14'-26' thick; but in N.Y. there are two beds 18" and 24" rarely reaching 30". In Penn. 4' is the maximum but in Ala. there are three beds which may aggregate as high as 37' (Pumpelly). Olive colored shales every where accompany them. In N.Y. the ore runs about 44 Fe in the furnace (A.H.Chester). These hematites as atated above have undoubtedly originated in many cases by the weathering of ferruginous limestone above the water level. Russel shows that the unaltered limestone in the bottom of a mine at Atalla Ala. 250' down contained but 7.75 Fe while the outcrop afforded 57.52, and J.B.Porter has shown the gradual increase of CaO in a mine in the same district from a trace at the outcrop to 30.55 at 130 ft below. Other writers have explained these beds as due to the bringing of iron in solution into the sea of the Clinton Age and depositing it as small nodules etc. or as a ferruginous mud (Rogers, Lesley, Newberry,). In this way an oolitic mass originated as in the modern Swedish lakes(Newberry).

Chamberlain T.C. Geol. Surv. Wis. Vol. I. p. 179.
Chester A.H. The Iron Region of Central N.Y. Utica 1881.

Rogers W.B. The Geology of the Virginias 1884. 103-106 (Elsewhere
Shurtleff S.P. Notes on the Black-band Iron Ores of W. Va. M.E.J.

Analyses of Specific Ores.

	Fe	CO_2	P	S	SiO_2	Al_2O_3	H_2O
Burden Mine N.Y. (Quicksilver)							
Ohio Black-band.	37.3			0.042	0.19	28.52	0.89
Kentucky (Clay ironstone).	33.82	20.0	0.0	0.67	0.14	10.56	5.42
Scotch Black-band	32.0	25.0			0.80	8.00	5.00
Pure Mineral	48.3	37.9					

Hematite, Red and Specular.

The sesquioxide of iron Fe_2O_3 is always of a red color when
powder, if of earthy texture this color shows in the mass and th
ore is called red hematite; if crystallized the red color is not
apparent and the brilliant luster of the mineral gives it the na
specular. The red hematites are first treated.

Type 6. Clinton Ore. One or more beds of red hematite inte
stratified with shales and limestones of the Clinton Stage. The
one of extraordinary persistence, as they outcrop in Wis. Ohio a
Ky., in the interior; and then begining in N.Y. south of Lake Ont
rio, they run easterly across the state. Again in Penn. they fo
low the waves of the Appalachian folds and run south in W.Va. an
Va. in great strength. Again they are found in Tenn. and Northe
ern Ga. and finally in Ala. are of unusual thickness and economi
importance. The structure of the ore varies somewhat, being in
places the replacement of fossils, such as crinoid stems, mollus
shells etc.(fossil ore). Again as small nodulyconcretions lik
flaxseed (flaxseed ore, lenticular ore), and elsewhere it is lam
ar dyestone ore. The ore is rarely a highly ferruginous limeste
and below the water level in the weathered portions passes often
into limestone, but along the outcrop it is quite rich. In Dodge
Co. Wis. the ore is 14'-20' thick but in N.Y. there are two bed
12' and 22' nearly reaching 30'. In Penn. 4' is the maximum but
in Ala. there are three beds which may aggregate as high as 27'
(Pumpelly). Oolite colored shales every where accompany them. In
N.Y. the ore runs about 44 Fe in the furnace (A.M.Chemists).
These hematites as quoted above have undoubtedly originated in a
manner by the weathering of ferruginous limestone above the water
level. Russel shows that the unaltered limestone in the bottom o
a mine at Anvil Ala. 280' down continued but 9.9% Fe while the
outcrop attended 37.82, and C.B.Porter has shown the gradual
ease of CaO in a mine in the same district from a trace at the o
crop to 30.88 at 180 ft below. Other writers have explained the
beds as due to the bringing of iron in solution into the sea of
the Clinton Age and depositing it as small nodules etc. or as a
ferruginous mud (Rogers, Lesley, Merrill). In this way an oolit
mass originated as in the modern Swedish lakes (Newberry).
Chamberlain T.C. Geol. Surv. Wis. Vol. I. p. 179.
Chester A.H. Ore from Region of Central N.Y. Utica Inst.

Hunt T.S. Coal and Iron in Ala. M.E. 11. 236.
Irving R.D. Mineral Resources of Wis. M.E.S. 438
Geol. Wis. Vol. I. p 625.
Newbary J.S. Geol. Surv. Ohio Vol.III. p.7.
Pontan J.P. Iron Ores & Coals of Ala. Ga. & Tenn. M.E. 15. 170
Rothwell R.P. Ala. Coal & Iron M.E. 2. 144.
Russell I.H. Subaerial Decay of Rocks. Bull.52. U.S. G.S. p.22. '89

Type 6a. Greenbrier Co. W.Va. A bed of red hematite in Oriskany sandstones. It probably corresponds to the Oriskany limonites elsewhere abundant but here dehydrated.

Page W.N. The Glenmore Iron Estate. Greenbrier Co. W.Va. M.E.17.115

Type 7. Crawford Co. Mo. Masses of associated specular, and hard and soft hematites of lenticular or funnel shape, in the Second Sandstone of the Missouri Lower Silurian. The hard and soft hematites have resulted from the alteration of the specular. The deposit invariably occurs in clay and chert which fill irregular cavities and hollows formed by the broken and faulted Second Sandstone. They are distributed in several counties in Central Mo. of which Crawford, Dent and Phelps are the most productive. They are thought by Dr. A. Schmidt (Mo. Survey 1873) to have either replaced preexisting rock or to have been originally deposited in hollows, in the then existing surface. Pumpelly however regards them (Vol. 15. 10th. Census p.12), as having been derived from the decay of the original dolomites and deposited in subterranean drainage channels. There is also a bed of red hematite associated with the Subcarboniferous sandstones of western centralMo.

Chauvenet W.M. 10th Census . Vol.15. 403
Schmidt A. Mo. Geol. Surv, 1874 Iron Ores and Coalfields .p.124

Type 8. Jefferson Co..N.Y. Beds of red hematite with more or less specular underlying Sandstones of the Potsdam Stage and associated with serpentine crystalline limestone and other sandstone beds, of uncertain relations. Not far away the Laurentian gneiss outcrops although nowhere associated with the ore. The beds occur along a northeast belt from Philadelphia, Jeff Co. to Gouvernour, St. Lawr. Co. They range up to 30' in thickness and are mostly of red earthy hematite with included masses of specular, Many interesting minerals,(siderite, millerite, quartz etc) are found in cavities. Emmons in the early N.Y. Survey (Geol.2nd Dist) attributed an eruptive origin to these ore beds and serpentine and even limestone , but this origin is controverted by Brooks, who first records the associated lower lying sandstone. Scarcely any one today would credit an intrusive origin. No satisfactory explanation has yet been advanced.

Brooks T.B. On Certain Lower Silurian Rocks in St. Lawrence Co. N.Y. A.J.S. III. 4. p.23.
Colby G.S. Jour. U.S.Assoc. Charc. IronWorkers Vol.XI p.263.
Emmons E. N.Y. Geol. Survey. 2nd Dist. p.93.

Type 9. Lake Superior Hematites. Beds of hematite both red and

Hunt T.S. Coal and Iron in Miss. N.Y. 1854.

Irving R.D. Mineral Resources of Wis. U.S.G.S. 1883

Pool. Wis. Vol. I. p 885.

Newberry J.S. U of. Geol. Ohio Vol. III. p.7.

Portwin J.P. Iron Ores & Coals of Ala. & Tenn. N.Y. 1875.

Rothwell R.P. Ala. Coal & Iron M.E. 8. 1884.

Russell I.C. Subaerial Decay of Rocks. Bull.52, U.S. G.S. p.17.

Typ: 6a. Greenbrier Co. W.Va. A bed of red hematite in Orisken sandstone. It probably corresponds to the Ordovicy limonite ore where abundant but have dehydrated.

Page W.M. The Glenmore Iron Estate. Greenbrier Co. W.Va. M.E.IV.1

Type 7. Crawford Co. Mo. Masses of associated specular, and hard and soft hematites of lenticular or funnel shape, in the Eureka Sandstone of the Missouri Lower Silurian. The hard and soft hematites have resulted from the alteration of the specular. The deepest invariably occurs in clay and chert which fill irregular cavities and hollows formed by the broken and faulted Second Sand stone. They are distributed in several counties in Central Mo. of which Crawford, Pont and Phelps are the most productive. They are thought by Dr. A. Schmidt (Mo. Survey 1873) to have arisen replaced preexisting rock or to have been originally deposited in hollows, in the then existing surface. Pumpelly however regards them (Vol. IS. 10th. Census p.123), as having been derived from the dolomitic and deposited in subterranean drainage channels. There is also a bed of red hematite associated with the Subcarboniferous sandstones of western central Mo.

Shumard W.M. 10th Census . Vol.15. 603

Schmidt A. Mo. Geol. Surv. 1873. Iron Ores and Geol fields .p.184

Type 8. Jefferson Co., N.Y. Beds of red hematite with more or less specular unde lying sandstones of the Potsdam Stage and associated with serpentine crystalline limestone and other sandstone beds, of uncertain relations. Not far away the Laurentian massif outcrops although nowhere associated with the ore. The beds extend along a northeast belt from Philadelphia, Jeff Co. to Governeur, St. Lawr. Co. They range up to 30' in thickness and are mostly of red earthy hematite with included masses of specular, many interesting minerals (siderite, millerite, quartz etc) are found in cavities. Emmons in the early N.Y. Survey (Geol.2nd Dist.) ascribed an eruptive origin to these ore beds and serpentine and syenite dikes and veins , but this origin is controverted by Brooks. The first recorded date associated lower lying sandstone. Several. and the today would credit an intrusive origin. No satisfactory explanation has yet been advanced.

Brooks T.B. On Certain Lower Silurian Rocks in St. Lawrence Co. N.Y. A.J.S. III. 6. p.33.

Colby U.S. Dept. U.S. Census. Chapt. Resources Vol.XI p.825.

Emmons E. N.Y. Geol. Survey. 2nd Dist. p.93.

Type 9. Lake Superior Hematites. Beds of hematite both red and

specular in crystalline schists and related rocks of the Huronian System, More or less Magnetite is also often present. Although of widely differing physical characters all the Lake Superior hematites are here grouped under one general type in order to avoid unnecessary subdivisions and to emphasize their closely related geological position. The individual characters are brought out by the sub-types. There are four principal ore producing belts, or districts, "The Marquette," just south of Lake Superior in Mich., "The Menominee", on the southern border of Mich. between the upper peninsular of Mich. and Wis., "The Gogebic" on the north western border between Mich. and Wis., "The Vermillion Lake" in Minn. northwest of Lake Superior.

Type 2a. Marquette District. The Marquette district was earliest known and has been most thoroughly studied. The Huronian rocks form a broad synclinal trough with subordinate folds, and several tongues or projections running out from the main body. They rest on and are bounded by Laurentian gneiss. The Huronian consists of quartzites, schists, banded jaspers, dikes altered to ""soapstone", limestone and the ores. Brooks divided it into twenty members. Beds VI. X. XII. and XIII. and an horizon below V. afforded the ore. Bed XIII affords the magnetite which increases in amount towards the western portion of the field. (Geology described at length in the lectures, with maps, sections and lantern views). The Ores are classed by Brooks under five heads, (a) Red Specular; (b) Magnetic; (c) Mixed; (d) Soft Hematites; (e) Flag Ores. Class (a) includes the slaty hematites which break into irregular tapering plates, and the massive so-called granular ores. Class(b) includes granular and more or less friable magnetites which are related to Type 1b. Class (c) includes the highly silicious ores, consisting of hematite closely interlaminated with red or white jasper. When containing over 45 or 50 per.ct. iron they are valuable. Class (d) are limonites closely related to Type 2a where they are referred to. Class (e) has a flaggy structure and are related to class (c) but are less distinctly banded and are merely local variations of ferruginous schists. On the east the soft hematites (limonites) are first met, then in going west the red hematites and then the magnetic character increases until at the western end of the district the magnetites are most abundant. There is a small outlier to the south of the district containing the Chesire mine. The ore bodies are true beds of greater or less extent, and often quite irregularly distributed. Their origin has been a subject of much controversy. The early explorers Foster and Whitney, attributed an eruptive origin to them, a difficult thesis lately attempted by Wadsworth (l.c. below). All the other geologists, who had studied them (Credner. Brooks. Pumpelly and at first Irving) attributed to them an origin like beds of limonite which were subsequently metamorphosed to hematite, in the general metamorphism of the region. Brooks thought it probable that the hematites were altered magnetites, an

idea confirmed by the presence of martite, but that all had been originally limonite.

Brooks T.B. Geol. Survey of Mich. Vol. I.
Credner.H. Zeitschr.d.d. geol. Ges. Vol.21. p.516. 1869.
B & H Zeit. 1871 p.369.
Foster and Whitney. Geol. of the Lake Superior Dist. Part. II.
Rominger.C Geol. Survey of Mich. Vol.IV.
Wadsworth.M.E.Notes on the Geol. of the Iron and Copper Dist. L.S.
Wedding Zeit.f.B.H.u.S.in p. Staat. XXIV. p.334.
Wright C.E.and Lawton C.D. Rept's of the Com. of the Mineral Statistics. Mich. 1870 and to date.

Type 9b. Menominee Dist. The rocks are essentially like those in the Marquette Dist. and the ore bodies have similar relations. The hematite is found in Bed VI. of Brooks' Scheme. The ores are generally soft blue hematites (powdering red) of earthy structure, and made up of very fine particles of specular. The brown hematites are of very limited occurrence, being known however in the Emmet Mine.

Brooks T.D. Wisconsin Survey. Vol.III. 430-433.
Brown D.H. Distribution of Phosphorus in the Ludington Mine.M.E. 17. 616.
Fulton J. Mode of Deposition of the Iron Ores of the Menominee Range Mich. M.E. 16. 525.
Larsson Per. The Chapin Mine. M.E. 16. 119.
Wright C.E. Wisconsin Survey. Vol. III. 366. 734. Also the papers cited under Type 9a.

Type 9c. Penokee. Gogebic Dist.. The rocks of this district are less metamorphosed than in the previous two. The strata run E and W with a northerly dip of 60 -80°, and no subordinate folds. They consist of cherty limestone at the base, followed by quartz-slates, quartzite, iron ore and ferruginous cherts, and finally slates and schists. The strata are traversed by dikes. The ore is a soft red somewhat hydrated hematite with more or less manganese, often considerable, and more abundant in the southern mines. Hard specular is rare. Irving first showed that these ore bodies had originated from the replacement of dolomitic or calcitic beds with iron oxide. Later Van Hise has shown them to be in the troughs formed by the intersection of northerly dipping compact quartzites and southerly dipping trap dikes. He traces the iron to a source in the layers of cherty carbonates parallel with quartzite and above it. From this it has been leached out by percolating water and deposited in the apices of the troughs where it has replaced the original carbonate rocks.

E & M Jour. Gogebic Range. Mar. 12. 1887. p. 182.
Irving R.D. Geol. Wis.. Vol. III pp. 200-207.
Origin of Ferrug. Schists and Iron Ores of L.S.
A.J.S. III. 32.263-265. Rec.

Brooks T.E. Geol. Survey of Utah. Vol. I.
Credner.H. Zeitschr.d.d. geol. Ges. Vol.21. p.512. 1869.
[illegible]
Foster and Whitney. Geol. of the Lake Superior Distr. Part II.
Foumier.C. Geol. Survey of Utah. Vol.IV.
"a davorth.N.H."ot a on.ite Mol. of the Iron and Copper Dist: L.S.
"adding. "oit.d.P.R.R.Exp. Survey. Stanat. XXIV. p.538.
"right C.E.and Dawton G.M. Expl's of the Yak. Territ. Final Report.
latdes. Utah. 1875 and up-date.
Type Cb. Monmouth Dist.. The rocks are essentially like those
in the "a'quette Dist." and the pre bodies have similar relations.
The Homa.ite is found in Bed VI. of Brooks' Section. The ores are
[illegible] soft blue Homa.ites (powdered [illegible]) of Garnet sandstone,
and mad. up of very fine particles of specular. The brown hematites
are of very limited occurrence, & thus known only in the Iron
Brooks T.B."Mechanical Survey: Vol.III. 1875[illegible]
Irons R.H. Distribution of Phosphorus in the Lauringon Iron. M.E.
17. 616.
Lurton J. Mode of Deposition of the Iron Ores of the Menominee
Range Distr. M.E. 16. 629.
Lawson Per. The Chapin Mine. M.E. 11. 119.
[illegible] G.E. Wisconsin Survey. Vol. III. 333. 734. Also the papers
[illegible] cited under Type Ca.
Type Cc. Pend.. Oreille Distr.. The rocks of this district are
less metamorphosed than in the previous two. The s.ra a.nd Z and
[illegible] with a vertical dip of 30 -60°, and no subsidiary folds. They
consist of shaly limestone at the base, followed by quartz-mica,
quartzite, iron ore and [illegible]ruginous shales, and finally slate and
schists. The s.rata are traversed by dikes. The ore is crystalline,
sometimes hydrated hematite, with more or less magnetite, often
[illegible]ably, and more abundant in the lean horizons. The specular
is rare. Having first removed that about the bodies had a lining
and from the replacement of dolomitic or calcitic beds [illegible] from
oxidol [illegible] as this "has shown them to be in the [illegible] form of
the intersection of nearly vertical [illegible] compact quartzites and
southerly dipping [illegible]. The true [illegible] The iron is scored in the
layers of cherty carbonates parallel with quartzite and above it.
From this it has been leached out by percolating water and deposited
[illegible] in the spaces of the [illegible] which replaced the original
carbonate rock.
[illegible] Geol. Surv. Mar. 12, 1900, p. 156.
Irving R.D. Geol. Wis. Vol. III pp. 399, 427.
Origin of Fe. Ores. Schists and Iron Ores of L.S.
A.J.S. III. 32.1886. 1886. Rep.

Van Hise C.R. The Iron Ores of the Penokee Gogebic Series in Mich. and Wis. A.J.S. Jan. 1889 p.32 Ref.
Wright C.E. Geol. Wis. Vol III pp. 239-301

Type 9d. Vermillion Lake Minn.. Beds of hard specular with but little soft, in a series consisting of jasper (so called jaspilyte of Minn. geologists) chlorite-schists and quartzite, with decomposed dikes now altered to "soapstone". They are situated some 70 miles north-west of Lake Superior and are analogous in their geological occurrence to the other subtypes. There are two iron bearing districts; one, to the west the Mesabi Range in which strata lie horizontal, and closely resemble the Penokee region contains magnetic ores, which have not as yet been rendered productive; the other, on the east, the Vermillion Lake, in which the strata lie nearly vertical affords the specular. In the latter district there are two belts a mile apart, of which the northern is the larger and most productive. They afford in many places a total of 30' clean ore. The northern deposit extends about one mile on the strike; the southern about one-half a mile.
Chester A.H. 11th Annual Rept. Minn. Geol. 155-167. Ref.
Comstock T.B. Vermillion Lake Dist. in Brit. America M.E. 16. 109
Winchell N.H. & others in the Ann. Repts. Minn. Geol. Survey. Also forthcoming Bulletin on Minn. Iron Ores., Minn. State Survey.

Type 10, Pilot Knob Mo.. Two beds of hard specular hematite, with a thin seam of slate between, interstratified with conglomerates and sheets of porphyry of the Huronian Series. The Ozark Mths of Mo. and Ark. bring to daylight through the Lower Silurian limestones and sandstones a series of knobs chiefly of porphyritic rocks. Such a one is Pilot Knob with its two ore beds. The lower bed has been the most productive and was from 25'-40' thick. The upper was thinner and less regular. They are now mostly worked out. (Views and Sections). Two neighboring porphyry knobs, Shepard M't'n. and Cedar M't'n. also contain ore in veins. The first a vein of clean magnetite, and another of pyritous do.: the second, one of specular, but neither hill affords much ore.
For Literature see under Type 11.

Type 11. Iron Mountain Mo.. Veins of hard Specular irregularly seaming a knob of porphyry. These veins are different from Pilot Knob deposit which is a true bed. They reach at times great thickness, 30'-40'-50' but also run out into the walls in small stringers and irregular masses. In such form they often show the cast of apatite crystals now weathered away. The chief source of the ore is not however at present the veins but is derived from a mantling conglomerate (the so-called "black ore,) of hematite and porphyry boulders with clay etc., which surrounds the knob and dips away under the later Silurian limestones and sandstones. It is the shore shingle of the early Silurian ocean. This is mined under the later formed Silurian strata and washed of its barren rock when brought to the the surface. An eruptive origin was originally ascribed to these

Mo. ores by J.D.Whitney, in later investigations Dr.Adolf Schmidt considers them both at Pilot Knob and Iron M't'n, to have been formed either by a replacement of the porphyries with iron oxide deposited from solution, or by a filling in the same way of fissures, probably formed by the contraction of the porphyry in cooling. Pumpelly also endorses this hypothesis, J.R.Gage has explained the Pilot Knob bed as originating by replacement, the iron being derived by lateral secretion.

Gage J.R. Trans. St.Louis Acad. Sci. 1873 pp.181-192.
Pumpelly R. and Schmidt A. Iron Ores and Coal Fields of Mo. 1873
Shepherd F. Ann.Rept. Mo. Geol.Survey. 1853-54
Whitney J.D. Met. Wealth. 1854.

Type 12. James River Va. Specular. Narrow beds of specular interstratified with quartzites and slates of metamorphic character and Archaean age. More or less clay is also bedded with the ore They run 4'-6' or less in width with prevailing vertical dip and furnish a very excellent grade of ore. They are situated along both sides of the James , a few miles north-east of Lynchburg. A few magnetite deposits are associated with them and some limonite.

Benton E.B. In the Census Rept. vol.15 p.263.
Campbell J.L. Resources of the James River Valley.
The Virginias, Monthly published by Jed. Hotchkiss Staunton Va.

Other beds of specular are known in Me., N.J., Ala. and in many metamorphic districts.

Analyses of Hematites. Red and Specular.

	Fe.	P.	S.	SiO	Al O	H O
Clinton N.Y. (Fossil Ore).	44.10	0.650	0.33	12.63	5.45	2.77
Wisconsin (Fossil Ore).	51.75	1.392				
Penn. (Mifflin Co).	44.4	0.115	0.028			
Tenn. (Meigs Co).	51.63	0.345				
Ala. Birmingham.	56.4	0.34		16.8	0.5	
Antwerp, N.Y.	46.32	0.033				
Mo. Crawford Co.	59.41	0.085				
Mich.Marquette Dist.(Specular).	68.4	0.53		2.07		
" " " "	64.83	0.057		3.60	2.03	
" Menominee Dist.	60.47	.009		3.38		
Mo. Iron M't'n	65.5	0.040	0.010	5.75		
" Pilot Knob	59.15	0.015		13.27	2.19	
James River Maud Vein	46.89	0.139				
Elba	61.81	0.02	0.17	6.97	3.47	
Pure Mineral	70.0					

These analyses are mostly taken from the State Reports and the Mineral Resources of the U.S.. They are intended to illustrate the general run of compositions, but for Marquette are high. Analyses necessarily vary widely.

Magnetite.

Type 13. Magnetite Beds. Beds of magnetite, often of lenticular shape, interstratified with Archaean gneisses and crystalline

Type 12. James River Va, Specular. Narrow beds of specular interstratified with quartzites and slates of metamorphic character and Archaean age. Iron or less clay is also bedded with the [illegible]. They run 4'-6' or less in width with prevailing vertical dip and furnish a very excellent grade of ore. They are situated along both sides of the James, a few miles north-east of Lynchburg. A few magnetite deposits are associated with them and some limonite. Denton I.E. In the Census Rept. Vol.15 p.253.
Campbell J.L. Resources of the James River Valley.
The Virginias, Monthly published by Jed. Hotchkiss Staunton Va.
Other beds of specular are known in Va., N.C., Ala. and in many metamorphic districts.

Analyses of Hematites. Red and Specular.

	Fe.	P.	S.	SiO	Al O	H
Clinton N.Y. (Fossil Ore).	44.10	0.650	0.23	13.01	5.45	2
Wisconsin (Fossil Ore).	61.75	1.302				
Penn. (Griffith Co).	46.4	0.118	0.058			
Penn. (Meiga Co).	51.63	0.345				
Ala. Birmingham.	55.4	0.34		15.8	0.5	
Antwerp, N.Y.	46.32	0.283				
Mo. Crawford Co.	59.41	0.085				
High Marquette Dist. (Specular).	58.4	0.53			2.07	
" " " "	64.85	0.087			3.50	2.05
" Ironmines Dist.	60.47	.005			3.72	
Mo. Iron Mt'n	65.5	0.040	0.010	6.75		
" Pilot Knob	59.15	0.015		13.27	2.15	
James River Sand Vein	47.80	0.139				
Elba	61.81	0.02	0.17	4.97	3.47	
Pure Mineral	70.0					

These analyses are mostly taken from the State Reports and the Mineral Resources of the U.S.. They are intended to illustrate the general run of compositions, but for Marquette are high. Analyses necessarily very widely.

Magnetite.

Type 13. Magnetite Beds. Beds of magnetite, often of lenticular shape, interstratified with Archaean gneisses and crystalline

limestones. They are extensively developed in the Adirondacks, in the N.Y. and N.J. Highlands and in western N.C..The presence of magnetite in Mich.(Type 9a) in Minn.(Type 9d) in Mo.(Type 10,in Shepherd M't'n), and in Va.(Type 12) has already been referred to. Other magnetite bodies are known in Col., Utah, Cal. and Wyoming and will be mentioned subsequently. Titanium is often present in such amounts as to render the ore of no value. The same is true of pyrite. Apatite is always found although it may be in very small quantity. Chlorite, hornblendeor augite, epidote, quartz, feldspar and a little calcite are the common associated minerals. In New Jersey the beds occur in several parallel ranges or belts.

Type 13a. Adirondack Region. The magnetite deposits occur in the foothills of the Adirondacks on all sides and to a less extent in the mountains themselves. The mountains are very largely knobs of massive rock which is chiefly labradorite with some hypersthene. Laid up against these in the foothills are gneiss and crystalline limestones, in the former of which occur the magnetite deposits . At Lyon M't'n on the north, the Chateaugay ore-body is really a bed of gneiss very rich in magnetite, rich enough in places to afford a merchantable ore. The greater part of it however requires concentration. It is known for several miles on the outcrop. On either side the ore shades out into the walls of barren rock. The little River Mines on the west side, in St. Lawrence Co. appear to be a similar but larger bed of lean ore. (Said to be 800'-1500' wide and 2 miles long).

Besides these extended beds, there are other deposits exhibiting more perfectly the peculiar lenticular shape characteristic of magnetite bodies, and to this class are to be referred the greater number of smaller bodies. They pinch and swell, roll and fold and feather out, and come off sharply from the walls. They often follow and overlap one another like shingles. They are not infrequently cut by trap dikes. Other deposits are of enormous size as at Mineville, (200'clear ore between the walls) and their relations are less clear. They may be large lenses folded or doubled over. The Champlain magnetite is quite notably granular as contrasted with New Jersey which tends to break in prisms. C.E.Hall divides these metamorphic rocks into the (a) Lower Laurentian Magnetite Iron Ore Series, containing the most important ore beds. (b) The Laurentian Sulphur Ore Series. (c) The Limestones and the Labrador or Upper Laurentian with Titaniferous Iron Ores. (c) is certainly later than (a) but the relations of (b) are uncertain. T.S.Hunt also states that the titaniferous ores are associated with the Labradorite Series or Norian.(Geog. Hist. Metals). Commercially the ores are divided into 1..ores high in phosphorus but low in Sulphur. 2.. Ores low in both phosphorus and sulphur. 3.. Pyritous ores. 4..Titaniferous ores.(Census Rept.Vol.18).

There are numerous magnetite deposits in Canada of analogous geological relations but they are often highly titaniferous.

Views showing the distributions and geological sections.
Credner H.Zeitsch.d.d.Geol.Ges. 1869 XXI.p.561, and
B. & H.Z. 1871 p 369.
Dana.J.D. On Theories of Magnetite. A.J.S. III. 22-152-402.
Emmons.E. Rept. on the 2nd. Dist. N.Y. Geol. Survey.
Hall.C.E. Ann.Rept. State Geol. N.Y. 1884.32nd. Ann.Rept.State Mus.
Smock.J.C. Bull.7. N.Y. State Mus.
Wedding Zeitsch.f.B.H.&S.in p.St. XXIV 330. 1876
Also general references cited above.
Silliman.B. Rem'ks on the Magnetites of Clifton St. Laurence Co.
N.Y. M.E. 1. 364.

Type 13b. N.Y. & N.J. Highlands. Beds of lenticular shape in Archaean gneiss and crystalline limestone. From Putnam N.Y. a ridge of Archaean runs S.W. across the Hudson River, Orange Co. N.Y. and northern N.J. into Penn. Lenses of magnetite occur throughout its entire extent. They are not as large as in the Adirondacks but are more regularly distributed. Four courses or belts have been recognized in N.J. The Ramapo, the Passaic, the Musconetcong, and the Pequest. The lenses strike north east with the gneisses, and usually have, like them, high dips. In addition they have also a socalled "pitch" along the strike so that they run diagonally down in the gneiss. Either by the overlapping of lenses or by an approximation to an elongated bed they sometimes, as at Hibernia, extend a mile or more. Again they may be almost circular in crossection. At Franklin Furnace one is found in crystalline limestone. The Tilly Foster ore body of Putnam Co. N.Y. has been most fully described, and attention is especially directed to it as a typical representative.

Compare also Franklinite deposits Type 28.
Cook,Geo.H. and Smock.J.C., N.J. Geol.Survey. 1868 Rec. and
subsequent Annual Rep'ts'.
Pullman.J.W. The Production of the Hibernia Mine.N.J. M.E.14. 904.
Ruttmann.T.S. Notes on the Geol. of the Tilly Foster Ore Body.
Putnam Co. N.Y. M.E. 15. 79. Rec.
Smock.J.C. The Magnetite Iron Ores of N.J. M.E.2. 314 Rec.
Wendt.A.F. The Iron Mines of Putnam Co. N.Y. M.E. 13473

Type 13c. Cornwall Penn.. Immense beds of soft magnetite associated with green slates, limestones and Triassic sandstones, and pierced by dikes of Triassic diabase. The exact geological relations of these beds have been greatly disputed, i.e., as to whether they are of Triassic or earlier age. They occur just at the junction of the older Siluro-Cambrian schists and the red Triassic sandstones, and in the same region are normal lenses in Archaean gneisses and slates. (Views and Sections). These beds have been thought eruptive, but are now generally regarded as metamorphic and Lesley's hypothesis that they were limonites like Type 2a. which have been metamorphosed by the trap seems most reasonable. (10th Census.Vol.15 p.11). (Compare also Type 14). Considerable amounts

Views showing the distribution and geological sections.
Gresham H.Zeitsch.d.d.Geol.Ges. 1889 XXI.p.881, and
B. & H.Z. 1871 p 865.
Dana.J.D. On Theories of Magnetite. A.J.S. III. 22-152-402.
Timons.M. Dept. on the 2nd. Dist. N.Y. Geol. Survey.
Vail.O.E. Ann.Rept. State Geol. N.Y. 1884.32nd. Ann.Rept.Parts in
Smock J.C. Bull.Y. N.Y. State Mus.
Wedding Zeitsch.f.B.H.Ss.in p.St. XXIV 330. 1876
Also general references cited above.
Silliman.B. Rem'ks on the Magnetites of Clifton St. Lawrence Co.
N.Y. M.E. I. 864
Type I3b. N.Y. & N.J. Highlands. Beds of lenticular shape in
Archaean gneiss and crystalline limestone. From Putnam N.Y. a rid
of Archaean runs S.W. across the Hudson River, Orange Co. N.Y.
northern N.J. into Penn. Lenses of magnetite occur throughout
-nsive extent. They are not as large as in the Adirondacks but
more regularly distributed. Four courses or belts have been reco
mixed in N.J. The Ramapo, the Passaic, the Musconetcong, and the
Pequest. The lenses strike north east with the gneisses, and
-nerally have, like them, high dips. In addition they have also a
-ocalled "pitch" along the strike so that they run diagonally dow
in the gneiss. Either by the overlapping of lenses or by an appro
-ximation to an elongated bed they sometimes, as at Hibernia, exhi
a mile or more. Again they may be almost circular in cross-section
At Franklin Furnace one is found in crystalline limestone. The
Tilly Foster ore body of Putnam Co. N.Y. has been most fully d
-ribed, and attention is especially directed to it as a typical
representative.
Compare also Franklinite deposits Type 2B.
Cook Geo.H. and Smock J.C.,N.J. Geol. Survey. 1868 Rep. and
subsequent Annual Rep'ts.
Fuldman.J.W. The Production of the Hibernia Mine.N.J. M.M.14. 90
Nettmann.I.S. Notes on the Geol. of the Tilly Foster Ore Body .
Putnam Co. N.Y. M.E. 15. 79. Rep.
Smock J.C. The Magnetite Iron Ores of N.J. M.M.R. 814 Rep.
Wendt.A.M. The Iron Mines of Putnam Co. N.Y. M.E. 1884?3.
Type I3c. Normall Perm. Lenses beds of soft magnetite asso
-ed with green slates, limestones and Triassic sandstones, and
-pierced by dikes of Triassic diabase. The exact geological rela
-ons of these beds have been greatly disputed, i.e. as to whether
they are of Triassic or earlier age. They occur just at the junc
-tion of the older Siluro-Cambrian schists and the red Triassic
-sandstone, and in the same region are normal lenses in Archaean
gneisses and slates. (Views and Sections). These beds have be
thought eruptive, but are now generally regarded as metamorphic
Lesley's hypothesis that they were limonites like Type 2a, writt
have been metamorphosed by the trap seems most reasonable. (Fi
Geaman Vol.15 p.11). (Compare also Type 14). Considerable amount

of Copper ores--chalcopyrite etc. occur with the magnetite in fissures running across it.

Fraser.P. A Study of the Spec. and Magnetic Iron Ores of the New Red Sandstones in York Co. Pa. M.E. 5.132.

Hunt.T.S. The Cornwall Iron Mines etc. M.E. 4. 319.

d'Invilliers E.V. The Cornwall Iron Ore Mines Leb. Co. Pa. M.E. 14. 873.

Rogers.H.D. 1st. Geological Survey Penn. II. 718.

Willis.B. 10th. Census.Vol. 15. p.223.

Type 13d. Western North Carolina. Beds of magnetite of the characters already described, in gneisses and schistose rocks. At Cranberry, which is the largest and best known, pyroxene is in marked association with the ore. In the southern central portions of the State the ore bodies are in mica and talcose schists referred by Kerr to the Huronian. Professor Kerr also makes a distinction between Upper and Lower Laurentian. The Cranberry beds are of great size and have lately become very productive.

Kerr.W.C. Geology of North Carolina 1875.

Type 13e. Rocky Mountain Region. Beds of magnetite of lenticular character either in rocks described as syenites and diorites, or between limestones and quartzites of supposed Silurian age. Magnetites are known in Colorado at Iron Mtn. Fremont Co. (too titaniferous to be valuable) of lenticular shape in diorite. (Rolker); in Chaffee Co. at the Calumet, Hecla and Smithfield Mines lenticular masses in decomposed Syenite (they furnish excellent ore); in Cost. 11 Co. in limestone (Census) or Syenite (Rolker); in Gunnison Co. at the Iron King, and Cumberland Mines, excellent ores in questionable Silurian quartzites and limestones. At Ashcroft near Aspen high up on the northern side of the Elk Mtn. is a great bed of magnetite. in limestones with abundant eruptive rocks near. It is thought by W.B.Devereux to be the altered outcrop of a pyrite deposit. There are other smaller deposits in different parts of the State. Some of the Colorado magnetites run into pyrite in depth and they have originated thus. Still pyrite is a common associate elsewhere.

Chauvenet.R. Papers on Iron Prospects in Col..Ann.Rep'ts Col. Sch. of Mines.1885-86-87.Also The Iron Resources of Col. Denver Meeting M.E. 1889.

Devereux.W.B. Notes on Iron Ore Deposits in Eaton Co. Col. M.E. 12. 608.

Rolker.C.M.Notes on Certain Iron Ore Deposits in Col. M.E. 14. 266.

In Wyoming an immense mass of titaniferous magnetite is known near Chugwater Cr..It is described (Hague) as resembling a great dike in grantie.

Hague.A. Iron Mtn. WYO. 40th Par. Surv. Vol.II p14.

Type 14. Utah and Cal. (1) Iron Co. Utah. Beds of magnetite and hematite in limestones of questionable Silurian age, bearing evidences of being metamorphosed limonites. The limestones have been

of Copper ores--chalcopyrite etc. occur with the magnetite in fis-
sures running across it.
Prasar,P. A Study of the Spec, and Magnetic Iron Ores of the New
Red Sandstones in York Co. Pa. M.E. 5.182.
Hunt,T.S. The Cornwall Iron Mines etc. M.E. 4. 319.
d'Invilliers E.V. The Cornwall Iron Ore Mines Leb. Co. Pa. M.E.
14. 873.
Rogers,H.D. Ist. Geological Survey Penn. II. 718.
Wilkie,B. 10th. Census.Vol. 15. p.225.
Type 134. Western North Carolina. Beds of magnetite of the char-
acters already described, in gneisses and schistose rocks.
At Cranberry, which is the largest and best known, pyroxene is in
marked association with the ore. In the southern central portions
of the State the ore bodies are in mica and talcose schists refer-
red by Kerr to the Hiwassian. Professor Kerr also makes a distinc-
tion between Upper and Lower Laurentian. The Cranberry beds are
great size and have lately become very productive.
Kerr.W.C. Geology of North Carolina 1875.
Type 135. Rocky Mountain Region. Beds of magnetite of uncertain
character either in rocks described as syenites and diorites, or
between limestones and quartzites of supposed Silurian age.
Magnetites are known in Colorado at Iron Mtn. Fremont Co. (too
titaniferous to be valuable) of lenticular shape in diorite.
(Rolker); in Chaffee Co. at the Calumet, Hecla and Smithfield Min
lenticular masses in decomposed Syenite (they furnish excellent
ore); in Coat. Ill. Co. in limestone (Genesee) or Syenite (Rolker);
Gunnison Co. at the Iron King, and Cumberland Mines, excellent ore
in quasticonsble Silurian quartzites and limestones. At Aspenrett
near Aspen high up on the northern side of the Elk Mtn. is a gree
bed of magnetite. In limestone with abundant eruptive rocks near
It is thought by W.P.Devereux to be the altered outcrop of a pyri
deposit. There are other smaller deposits in different parts of
the State. Some of the Colorado magnetites run into pyrite in dep
and they have originated thus. Still pyrite is a common associate
elsewhere.
Chauvenet,R. Papers on Iron Prospects in Col..Ann.Rep'ts Col. Bur
of Mines,1885-86-87.Also The Iron Resources of Col.
Denver Meeting M.E. 1889.
Devereux,W.B. Notes on Iron Ore Deposits in Gunnison Co. Col. M.E.
12. 808.
Rolker,C.M.Notes on Certain Iron Ore Deposits in Col. M.E. 14. 86
In Wyoming an immense mass of titaniferous magnetite is known nea
Chugwater Cr.. It is described (Hague) as resembling a great dike
in granite.
Hague,A. Iron Mtn. WYO. 40th Par. Surv. Vol.II pl4.
Type 14, Utah and Col. (1) Iron Co. Utah. Beds of magnetite an
hematite in limestones of quasticonsble Silurian age, bearing evi-
dences of being metamorphosed limonites. The limestones have been

much upturned and metamorphosed and pierced by dikes and eruptive masses of trachyte(?). In the Star Dist. in the same region the ore apparently lies between quartzite and granite. Hematite occurs in large amount associated with magnetite. Quartz is abundant in the ore of some claims, and also in certain streaks large crystals of apatite. The importance of these deposits lies in the future.

They are doubtless the largest in the west. They are interesting in their bearing on the general origin of magnetites.

Blake W.P. Iron Ore Deposits of Southern Utah M.E. 14, 809.
Newberry J.S. The Genesis of Our Iron Ores. S.of M. Quar. Mar. 1880
E.& M. Journal April 23 1881 p.286. Proc. Nat'l Acad. 1880.
Putnam B.T. 10th Census. Vol.15 p.486

(2) California Magnetite. Beds of magnetite of lenticular shape in the metamorphic slates and limestones of the western slopes of the Sierras. Deposits of excellent ore are known in Sierra and Placer Counties often succeeding one another for a considerable stretch on the strike.

Browne J.R. Rept. on Mining Resources etc. W. of Rocky M't'ns. 1868
King C. & Hague J.D. In Raymonds Mines and Mining W. of Rocky Mountains 1874 p.44.
Hanks H.G.& Irelan Wm. Ann. Rep'ts of the Cal. State Mineralogist.
v.Richthofen F. Private Report quoted in 10th Census Vol 15 p.493.
Whitney J.D. Geol. Surv. Cal.. Rep. 1865. Vol.I.

Type 15. Magnetic Sands. Beds of magnetite sands concentrated on beaches by the waves. Such deposits are very abundant at Moisie on the St. Lawrence below Quebec, and in the U.S. are known in smaller developments on Lake Champlain, at Quogue L.I. and in Conn. along the Great Lakes and on the Pacific. Grains of garnet, olivine, hornblende etc. Minerals of high specific gravity are associated with the sands. Since the introduction and use of blotting paper they are less worked than formerly.

Hunt T.S. Geol. Surv. Can. 1866-69. 261-262. Can.Nat.VI,p.79, 1872
Julien.A.A. The Genesis of the Crystalline Iron Ores, Proc.Acad. Nat. Sci. Phila. 1882.p.335. E.&M. Jour. Feb. 2nd 1884.

On the Origin of Magnetite Deposits.

It is important to note that they are almost, if not quite invariably in metamorphic rocks (gneises especially, less often crystalline limestones etc.) and conformably interbedded. As the exact history of these metamorphic rocks is as yet uncertain, the origin of the magnetites shares the same doubt. In eruptive rocks magnetite in small grains is the most universally distributed of the minerals. The following hypotheses have been advanced.

1.. The intrusive (eruptive) Hypothesis; an origin analogous to a trap dike. (Now very generally rejected).

2.. Altered limonite or bog ore hypothesis. From limonite beds either formed in marshes(See Type 1.) or in lakes (See Type 6.) or as in Types2 and 2a. Subsequent metamorphism of these beds and the enclosing rocks, changes the former to magnetite and the latter to

gneisses etc.. This seems to have been shown for the Cornwall (Type 13c) and Utah, (Type14) and is the hypothesis having the endorsement of many authorities. The limonite may also have been derived by the alteration of lenses of pyrites, and these metamorphosed, as in Col. Type 14a.

3.. The Beach Sand hypothesis. Beds of magnetite sands derived from the weathering of massive rocks and concentrated by waves and then buried and metamorphosed. This is by no means improbable in many instances.

4.. The River-bed hypothesis. That the lenses are due to a concentration of magnetite sands in rivers, or flowing currents. Hence the overlapping lenses, the arrangement in ranges or on line of drainage, and the frequent swirling curves found on the feathering edges of lenses.(Original with Prof.H.S.Munroe of Columbia, privately communicated).

In regard to the magnetite lenses of the Archaean Gneisses while the hypotheses above cited are often reasonable, yet most candid observers have grown with widened experience, less positive in asserting them.

Analyses of Magnetites.

	Fe	P	S	TiO	SiO	Al O
Chateaugay Ore.	49.24	0.029	0.052		18.447	1.363
" " Washed.	66.00	0.003				
Lake Champlain (Mine 21)	62.10	1.198				
Orange Co. N.Y. (F.ofD.)	63.00	0.621	0.148			
Putnam Co. N.Y.	48.82	0.021	0.08		11.75	3.50
New Jersey (Hibernia)	53.75	0.364				
Cornwall Pa.	42.7	0.135	0.020			3.411
Cranberry N.C.	64.64	0.004	0.115			
Col. Calumet,	49.23	0.026			3.85	
Canada (Rideau Canal)	50.23.			9.80		
Col. Iron King	58.75	0.044	0.123			
Utah	62.6		0.12		4.80	
Cal. Gold Valley	60.687				15.87	

Of importance in connection with iron ore deposits are the recent studies of the distribution of phosphorus along certain lines in the beds, by a knowledge of which it is possible to keep more valuable bessemer ores(under 0.1% P) distinct from less valuable non-bessemer. Such lines have been found in Mich. and have been called by Mr Browne "isochemic lines". Though less marked at the Burden Mines (Type 3) the phosphorus was characteristic of certain varieties of the ore.

Browne D.H. On the Distribution of Phosphorus at the Luddington Mine etc..M.E. 17 616.

Olmsted.I. The Distribution of Phosphorus in the Hudson River Carbonates. M.E. Col. Meeting June 1889.

Analyses of Magnetites.

	Fe	P	S	TiO	SiO	Al
Chateaugay Ore.	40.3%	0.029	0.062		18.44?	1.
" " Washed.	56.88	0.093				
Iron Champlain: (Mine 21)	62.15	1.198				
Orange Co. N.Y. (Cornwall)	63.00	0.857	0.148			
Putnam Co. N.Y.	48.38	0.021	0.08		12.75	2.
New Jersey. (Hibernia)	53.75	0.364				
Cornwall Pa.	42.7	0.135	0.029			3.
Cranberry N.C.	64.64	0.004	0.118			
Col. Calumet.	49.23	0.028			4.68	
Canada (Rideau Canal)	50.23				9.89	
Col. Iron King	58.75	0.044	0.122			
Utah	68.6		0.12		4.80	
Cal. Gold Valley	60.087				15.87	

Importance in connection with iron ore deposits are recent studies of the distribution of phosphorus along certain lines in the beds, by a knowledge of which it is possible to ke more valuable basemer ores(under 0.1% P) distinct from less va ble non-bessemer. Such lines have been found in Utah, and ha been called by Mr Brooks "isochemic lines". Though less marked the Burden Mines (Type 3) the phosphorus was characteristic of certain varieties of the ore.

Brown D.H. On the Distribution of Phosphorus at the Lackawanna Mine etc..M.E. IV 816.

Olmsted.I. The Distribution of Phosphorus in the Hudson River Carbonates. M.E. Col. Meeting June 1899.

Pyrite.

Type 16. Pyrite Beds. Beds of pyrite often of lenticular shape and character analogous to the magnetite deposits, in slates, schists and less often gneiss of the Cambro-Silurian System, or Archaean group. Slates are most common, and gneiss least so. They extend from Canada, down the Appalachians to Ala., being found at Vershire Vt. Charlemont Mass, (Anthony's Nose N.Y., (the Gap Mine Penn. being pyrrhotite will be mentioned under Nickel with other similar occurrences), Louisa Co. Va. Ore Knob. N.C. and Ducktown Tenn. and at many points less well known in Ala.. Also at Sudbury north of Lake Superior recent developments have shown another.

They lie interbedded in the slates and., often the different lenses overlap and succeed each other in the footwall, and exhibit all the phenomena cited under magnetites. Copper pyrites is usually present in small amount and where the copper reaches 4 or 5 % they are valuable as copper ores (See under Copper). At present they are of increasing importance as a source of sulphuric acid fumes for the manufacture of sulphuric acid. Small amounts of lead and zinc sulphides are often present, rarely a little silver and nickel and cobalt especially in the pyrrhotitic varieties. They are worthless as a source of iron. The auriferous pyrites of the southern states will be mentioned under gold. (Views and Sections).

They have probably accumulated in a way analogous to the Bog Ore Hypothesis cited under Magnetite, but instead of the iron being precipitated as oxide it has probably come down as sulphide from the influence of decaying organic matter, and has subsequently shared in the metamorphism and solidification of the wall rock. At the same time it must be admitted to be an obscure point.

Adams W.H. The Pyrites Deposits of Louisa Co. Va. M.E. 12. 527.
Boyd C.R. The Utilization of the Iron & Copper Sulphides of Va. N.C. and Tenn. M.E. 14, 1881.
" Resources of S.W. Va.
Credner H. At St. Anthony's Nose Hudson River B.& H. Zeit.1866 p.17
" Pyrite in Va. Tenn. & Geo. B.& H. Zeit 1871 p. 370
Davis H.T. Min. Resources M.S. 1883-84 p.501
Wendt.A. The Pyrite Deposits of the Alleghanies. Sch .ofM.Quarterly Vol. VII. and as separate reprint, also E.& M. Jour. June 5th 1886 p.22 and elsewhere.
Wheeler H.A. Copper Deposits of Vt. S.of M. Quarterly IV 219.

Statistics of Iron Ore.

In 1880 the total iron ore mined in the U.S. was 7.974806 tons of which limonite, 2.119.218 or 27.6 % of total, spathic 922.288 or 11.5 %, fossil(Clinton) 615.573 or 7.6 % , Spes. hematite, 1.896. 918 or 23.6% , magnetite, 2.387.369 or 29.7 %. The States ranked in the following order Penn. Mich., N.Y., N.J., Ohio, Missouri, Ala. Va., Md., Tenn., Ga., Ky., etc.. Mich. now produces the most, and others have come up, but the data for very accurate ranking at present are not available.

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Adams W.H. The Pyrites Deposits of Louisa Co. Va. M.E. 12, 527.
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Resources of S.W. Va.
Dresher H. At St. Anthony's Nose Hudson River E.& M. Zeit. 1886 p.[illegible]
Pyrite in Va., Tenn. & Geo. E.& M. Zeit 1871 p. 370
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In 1882 Great Britain	13.622.240	Other Countries (except the	
United States	10.080.000	following)	1.102.000
Germany	8.981.473	1881-Austria Hungary	1.157.100
France	3.857.000	Sweden	910.532
Belgium	275.500.	1880-Russia	1.128.319
Spain	5.510.000.	1886-United States	10.000.000
Italy	385.700.	1887- " "	11.500.000

Copper.

		Cu	S	Fe
Native Copper (Generally some Silver).		100		
Chalcocite	Cu_2S	79.8	20.2	
Chalcopyrite	$CuFeS_2$	34.6	34.9	30.5
Bornite	$CuFeS_3$	61.79	25.8	11.7
Tetrahedrite	4 CuS Sb_2S_3 (Variable)	36.40	26.7	11589
Cuprite	Cu_2O	88.8		
Melaconite (Tenorite)	CuO	79.86		
Malachite	2CuO CO H O	57.4		
Azurite	$3CuO+CO_2+H_2O$	55.0		
Chrysocolla	$CuO+SiO_2+2H_2O$	36.1		

Type 16. Pyrite Beds with intermingled Chalcopyrite.

See above page 26. Pyrites (called Mundic by the miners) is the principal constitutent of such bodies but often the copper percentage reaches 4-5 % and they are valuable for copper. They have been worked for this metal at Capelton Quebec, just north of Vt., at Vershire or Ely, Vt., Ore Knob and Blue Wing N.C. and Ducktown Tenn. and at various smaller beds in Md. and elsewhere. The beds are often altered on the surface giving the rusty ferruginous and oxidized outcrop known as gossan. From such decomposed material at Ducktown the copper leached out and became concentrated at the water line in a zone of very rich ore (called "black ore") consisting largely of chalcocite, melaconite, and the carbonates.

Below however were found the iron and copper sulphides. Considerable subterranean heat is developed at Ducktown by the oxidation of the sulphides. All these deposits are now of less importance than in former years as a source of copper, and but few are at present in operation. For Sudbury, Ontario see under Nickel.

(Views, sections, and particular descriptions).

Bailey J.T. The Copper Deposits of Adams Co. Penn. E.&M.J. Feb. 17th 1883 P. 88.

Credner H. On Ducktown Tenn. B.&H. Zeit.1867p.8

E.& M.Jour. Nov.6 1886 p.327. The Elizabeth Copper Mines Vt. See also April 10th. 1886.

Fraser P. Some Copper Deposits of Carroll Co. Md. M.E. 9. 33.

" Hypothesis of the Structure of the Copper Belt of the South Mountain Penn. M.E. 12. 1882.

Henderson C.H. Copper Deposits of the South Mountain Penn. M.E. 13.385.

Hunt.T.S.Ore Knob [illegible] some related Deposits. M.E. 2.123.

Kleinschmidt. (In Va. Tenn. and N.C.) Gangstudien. Vol.3 p.256 (good short account).

In 1882 Great Britain 58,000,000 Other Countries (except the
United States 30,000,000 Spain) 1,100,000
Germany 8,000,000 Russia 1,100,000
France 8,867,000 Sweden 910,000
Belgium 875,000 1880-Russia 1,100,000
Spain 5,810,000 1882-United States 10,000,000
Italy 688,700 1887- " 11,800,000

Copper.

		Cu	S	Fe
Native Copper (generally some Silver).		100		
Cuprite	Cu_2S	79.8	20.2	
Chalcopyrite	$CuFeS_2$	34.5	34.9	30.6
Bornite	Cu_5FeS_4	61.79	25.8	11.7
Tetrahedrite	$4 Cu_2S\ Sb_2S_3$ (Variable)	36.40	26.7	36.9
Cuprite	Cu_2O	88.8		
Melaconite (Tenorite)	CuO	79.80		
Malachite	$2CuO\ CO_2\ H_2O$	57.4		
Azurite	$3CuO\ 2CO_2\ H_2O$	55.0		
Chrysocolla	$CuO 4SiO_2 2H_2O$	36.1		

Type 5. Pyrite Beds with interminated Chalcopyrite.

See above page 26. Pyrites (called Mundic) by the miners) is the principal constituent of such Beds but often the copper percentage reaching 6 or 7 and they are valuable for copper. They have been worked for this metal at Eagleton Quebec, just north of Mt. Orford Vermont or Ely, Vt., Ore Much and Blue Ville P.Q. and Ducktown Tenn. and at various smaller beds in N.E. and elsewhere. The beds are often altered on the surface giving the rusty Gossan[ous] and oxidized enterop known as gossan. From such decomposed material at Ducktown the copper leached out and became concentrated at the water line in a zone of very rich ore (called "black ore") consisting largely of chalcocite, melaconite, and the carbonates.

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(Views, sections, and particular descriptions).

Bailey L.T. The Copper Deposits of Adams Co., Penn. B.G.S.A. Vol. 7th 1895 P. 89.

Credner H. On Wentzel Tenn. B.G.S.A. Vol. 1 1890.

E.& M. Jour. Nov. 8, 1890 p. 537. The Elizabeth Copper Mines Vt. Same also April 10th. 1890.

Fraser P. Some Copper Deposits of Carroll Co., Md. M.R. 56.

(Hypotheses of the Extraction of the Copper Belt of the South Mountain Penn. M.R. 15. 1885.

Henderson G.H. Copper Deposits of the South Mountain Pennsylvania. Mont. T. [illegible] Kleinschmidt [illegible] Geology [illegible] p. [illegible]

Olcott E.E. Ore Knob Copper Mine and Reduction Works. M.E. 3, 391
Richardson. Copper Ore of Stafford Vt. A.J.S. I. 21 383.
Tuomey M. A brief Notice of some Facts connected with the Ducktown Tenn. Copper Mines. A.J.S. II. 19 181.
Wendt.A.F. The Pyrites Deposits of the Alleghanies S.of M. Quarterly. Vol. 7. 1886. E.& M.J. July 10th & following 1886.
Wheeler H.A. Copper Deposits of Vt. S.of M. Quarterly IV 219

Type 16a. Spenceville Cal. Beds of pyrites with considerable chalcopyrite in Jurassic slater on the western slopes of the Sierra Nevada. The ore affords about 3. 2 % copper. The deposits are known in several counties but are only of notable importance at Spenceville, Nev. Co. and Newton, Amador Co. The same slates afford the gold veins which are numerous near the copper mines.

Ellis J.E. Min. Resources. 1884. page 340.
Hanks.H.G. & Irelan.W. Rep'ts of Cal. State Mineralogist. Scattered Mention.

Type 16b. Gilpin Co. Col.. Bodies of pyrite, chalcopyrite and bornite replacing gneiss (or perhaps granite) and dikes of quartz porphyry and felsite, along the planes of the joints, which cross the gneiss perpendicular to the laminations. These ores occupy a very limited extent of territory (1 1/2 miles in diameter) but as they are highly auriferous are vigorously mined primarily for gold. The concentrates from the stamp are afterwards treated for copper but as an accessory to the metallurgy of the precious metals. They will be again refered to, under gold.

Emmons S.F. 10th Census. Vol. XIII p.68. The veins are described as cited above.
Hague J.D. 40th Parallel Survey III p.493 The veins are called fissure veins by Mr Hague.
Lakes A. Ann. Rep. Col. State Sch. Mines 1887 P CII.
Rogers A.W. The Mines and Mills of Gilpin Co. Col. M.E. 11. 29.

Type 16c. Llano Co. Texas. Impregnations in granite and veins with quartz gangue in granite, carrying carbonates above but sulphurets and tetrahedrite, with some gold and silver below. Contact deposits between slates and granite are also known.

Streeruwitz W.H. Mineral Res. U.S. 1884 p.342.

Type 17.. Butte Mont.. Veins, orriginally fissures but greatly enlarged by replacement of the walls with ore, filled with copper sulphides, bornite, chalcopite etc. in a siliceous gangue. Some silver is associated with the copper. At Butte there is a north and south valley 6 miles wide between high granite ridges on the east and lower rhyolite ridges on the west. In the middle arrises also a conical hill of rhyolite (the "Butte"). In the eastern part of the valley is a very basic dark granite and also on the extreme west.

In the part west and south west of the "Butte" is a highly acidic light colored granite. In these granites east and west of the Butte are the veins. On the east in the basic granite are two series, of which the southern is the copper bearing . The northern and also

Olcott E.E. Ore Knob Copper Mine and Reduction Works. M.E. p. 391
Richardson. Copper Ore of Stafford Vt. A.J.S. I. 21 383.
Tuomey M. A brief Notice of some Facts connected with the Ducktown Copper Mines, A.J.S. II. 19 181.
Wendt A.F. The Pyritic Deposits of the Alleghanies S.of M. Quarterly. Vol. V. 1888. E.& M.J. July 10th & following 1888.
Wheeler H.A. Copper Deposits of Vt. S.of M. Quarterly IV 289.

Type 18a. Spencerville Cal. Beds of pyrites with considerable chalcopyrite in Jurassic slates on the western slopes of the Sierra Nevada. The ore affords about 3% copper. The deposits are known in several counties but are only of notable importance at Spencerville, Nev. Co. and Newton, Amador Co. The same slates afford the gold veins which are numerous near the copper mines.

Hanks H.G. & Irelan, W. Rep'ts of Cal. State Mineralogist. Scattered Mention.
Ellis J.E. Min. Resources. 1884. page 340

Type 18b. Gilpin Co: Col. Bodies of pyrite, chalcopyrite and bornite replacing gneiss (or perhaps granite) and dikes of quartz porphyry and felsite, along the planes of the joints, which cross the gneiss perpendicular to the laminations. These ores occupy a very limited extent of territory (1½ miles in diameter) but as they are highly auriferous are vigorously mined primarily for gold.

The concentrates from the stamp are afterwards treated for copper but as an accessory to the metallurgy of the precious metals. They will be again referred to, under gold.

Emmons S.F. 10th Census. Vol. XIII p.58. The veins are described as cited above.
Hague J.D. 10th Report of Survey III p.493. The veins are called fissure veins by Mr Hague.
Lakes A. Ann. Rep. Col. State Gen. Mines 1887 p 911.
Rogers A.W. The Mines and Mills of Gilpin Co. Col. M.E. II. 29.

Type 18c. Llano Co. Texas. Impregnations in granite and veins with quartz gangue in granite, carrying carbonates above but sulphurets and tetrahedrite, with some gold and silver below. Contact deposits between slates and granite are also known.

Streemwitz W.H. Mineral Res. U.S. 1886 p.542.

Type 17. Butte Mont. Veins, originally fissures but greatly enlarged by replacement of the walls with ore, filled with copper sulphides, bornite, chalcopyrite etc. in a siliceous gangue. Some silver is associated with the copper. At Butte there is a north and south valley 6 miles wide between high granite ridges on the east and lower rhyolite ridges on the west. In the middle arrises also a conical hill of rhyolite (the "Butte"). In the eastern part of the valley is a very basic dark granite and also on the extreme west.

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The veins west of the Butte are silver-bearing and will be referred to under silver. Strangely enough thy lack copper quite entirely. The Butte district is alone rivaled by the Lake Superior district in output; see table below.

Emmons, S.F. Notes on the Geology of Butte, Mont. M.E. 16, 49. See also under Silver.

E.& M. Jour., Butte Copper Mines. April 24, June 19, 1886.

Peters E.D., Mineral Resources U.S. 1883-84. p.374.

Williams & Peters. On Butte Montana. E & M. Jour. Mar. 28. 1885 p.208.

Type 18., Keweenaw Point, Mich.. Native copper with some silver in both sedimentary and interstratified massive rocks of the Keweenian System. It occurs as a cement binding together and replacing the pebbles of a porphyry conglomerate; or filling the amygdules of the upper surface of the interbedded sheets of massive rocks; or as irregular masses, sometimes of enormous size, in veins with a gangue of calcite, epidote and various zeolites; or in irregular masses along the contact between sedimentary and massive rocks.

The rocks of the Keweenian System are most strongly developed on the south shore of Lake Superior, especially in Keweenaw Point. They extend some distance east and west and are also known on the north shore. They consist of sandstones and thin beds of conglomerate interstratified with sheets of diabase, both compact and amygdaloidal, and of melaphyre. There are three principal mining districts, the Keweenaw Point on the end of the Point, the Portage Lake in the middle, and the Ontonagon at the western base, mines have also been worked on Isle Royale and copper is found in small amounts on the north shore. The Portage Lake is now the principal, if not the only producer. In the first named district the mines are on original fissures which have later become much enlarged by the alteration of the walls. They are usually from 1' to 3' broad but may reach 10' to 20' and 30', this latter in the looser textured rocks. These expansions are also richest in copper, The veins stand nearly vertical and cross the beds at right angles. They were the earliest disvovered and the first to be extensively worked.

In the Portage Lake district the mines are either in conglomerate (Calumet and Hecla, Tamarack, Peninsular, etc) or in amygdaloidal, strongly altered diabase, certain very scoriaceous beds of which are known as the ash beds (Quincey, Franklin, Atlantic etc.).

In the conglomerates the copper has replaced the finer fragments so, as to appear like a cement and often the boulders themselves, or particular minerals in them so that they are permeated with copper. The amygdaloids have copper in their small cavities, but in the open or shattered rock it fills all manner of irregular cavities, often in fragments of great size. It is associated with calcite, the zeolites (of great beauty), epidote and chlorite (the last containing Fe_2O_3). In the Ontonagon district the copper follows planes, approximately parallel to the bedding of the sandstones and massive rocks, and in one case at least (the National Mine) along

The veins west of the Butte are silver-bearing and will be referred to under silver. Strangely enough the lack copper quite entirely. The Butte district is alone rivaled by the Lake Superior district in output; see table below.

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Peters E.D. Mineral Resources U.S. 1883-84. p.374.

Williams & Peters, On Butte Mountains, E. & M. Journ. Mar. 29. 1884 p.209

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the contact between the two. The copper is quite irregular in its distribution but has the same associates that are mentioned above.

In thier practical bearing the mines are classed as Mass Mines, Amygdaloid Mines and Conglomerate Mines.

On the Origin of the Copper.

The original source of the copper was thought by the earlier investigators to be in the eruptive rocks themselves and that with them it came in some form to the surface to be subsequently concentrated in the cavities. Pumpelly has refered it to copper sulphides distributed through the sedimentary rocks as well as the massive, from which the circulating waters have leached it out as carbonate, silicate and sulphate. Although the traps are said by Irving to be devoid of copper, except as secondary, it would be interesting to test in a large way thier basic minerals as has so successfully been done by Sandberger on other rocks, for the metal. I think it probable that such may be its source. Irving states that the coarse basic gabbros of the System contain chalcopyrite, but they do not occur nearthe productive mines. The electro-chemical hypothesis of deposition was earliest advocated(Foster and Whitney) and on account of the electrolytic properties of the two metals it would appear probable, although the unsatisfactory character of all experiments militates against it. Pumpelly however has worked out an explanation much more likely to be the true one. He found on studying the mineralogical changes which had taken place in the rocks, that the alteration had been very extensive; that it had proceeded through a series of minerals involving at one stage a change in the iron present from protoxide to sesquioxide, which would occasion a reducing action and at this stage the copper was deposited. (Mention of the deposit of Melaconite at Copper Harbor. Historical account of the development of the mines, Prehistoric Mining.) Views and Sections.

It would be impossible and undesirable to give in this place any complete reference to the literature. Such bibliography will be found in Irvings Monograph, and in wadsworth. The more important papers are givern below.

Blake W.P. Mass Copper of L. Sup. Mines etc..M.E. 4. 110.
Credner H. Neues Jahrbuch 1869 p.1.
E.& M.Jour. History of Copper Mining in the Lake Superior District March 18th 1882. p. 141.
Foster and Whitney Rept on the Lake Superior Copper Lands 1850.
Irving R.D. The Copper-bearing Rocks of Lake Superior Monogr. V. U.S. Geol.Survey Esp. p. 419 Rec.
Pumpelly R. Geol. Survey of Mich. 1873. Vol. I.
" On the Origin of the Copper. A.J.S. III. 2. 188-198, 243-258, 347-353 Rec. A later and fuller paper is in
" Proc. Amer. Acad. 1878. Vol. 13. p. 233.
Wadsworth.M.E. Notes on the Geol. of the Iron and Copper Dist. Lake Superior. Cambridge 1880.

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Blake W.P. Mass Copper of L. Sup. Mines etc. A.J.S. 4. 110.
Credner H. Neues Jahrbuch 1859 p.1.
R.& M.Jour. History of Copper Mining in the Lake Superior District March 18th 1882, p. 141.
Foster and Whitney Rept on the Lake Superior Copper Lands 1850.
Irving R.D. The Copper-bearing Rocks of Lake Superior Monogr. V.
U.S. Geol.Survey Rep. p. 419 Rec.
Pumpelly R. Geol. Survey of Mich. 1873. Vol. I.
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" Proc. Amer. Acad. 1878. Vol. 13. p: 253.
Wadsworth M.E. Notes on the Geol. of the Iron and Copper Dist. Lake Superior. Cambridge 1880.

the granite. Copper is known elsewhere in sandstones, and the Lake Superior conglomerates (See Type 18) where it has been reduced to the metallic state are of interest in this connection.

(Note). There are numerous other copper districts in Arizona of minor importance or entirlly undeveloped, but the types above cited probably illustrate the occurrences quite fully. Mention should be made also of the mines in Lower California opposite Guaymas.

Blake W.P. The Copper Deposits of Copper Basin Arizona. M.E. 479
E.& M. Jour. Arizona Copper & Copper Mines Aug. 13 1881 p. 103
" The Clifton Copper Mines Arizona. Feb 21. 1880 p. 133.
" The Globe Dist. April 9 1881 p.248.
Henrich C. The Copper Ore Deposits near Morenci Arizona E.& M.Jour. March 26 1887. p.435.
Tuttle A. Occurrences of Gold and Silver in Oxidized Copper Ores in Arizona. E.& M. Jour. June 16 1888. 435.
Wendt A F. Copper Deposits of the Southwest. M.E. 15-25 also condensed in the E.& M. Jour. Feb. 5. 1887 and in subs. Nos.
Wislizenus. Santa Rita Mines Memoir of a Tour in Northern Mexico page 47. (Historical).

Type 20g.. Wyoming. Oxidized Ores are found at the Sunrise Mines in the Laramie Range and some copper has been produced.

Type 20h.. Crismon Mammoth. Utah. A great vein in dolomitic limestone carrying copper, gold and silver ores. In the Tintic district 70 miles south west of Salt Lake City, are a number of veins which produce considerable copper as accessory to the precious metals. The veins , or belts are of great width and afford rich chutes or chimneys amid much low grade ore or gangue. They will be referred to again under the precious metals.

Huntley D.B. 10th Census Vol. 13 p. 456.
Hollister O.J. Gold and Silver Mining in Utah. M.E. 16 p 10.

Type 21.. Copper Ores in Triassic Sandstone. Oxidized ores native copper and chalcocite in contact deposits in Triassic sandstones at their junction with diabase or gneiss or as disseminated masses replacing organic remains. Copper ores are very common throughout the estuary Triassic rocks of the Atlantic coast and although formerly much mined are now proved valueless, and only of scientific interest.

Type 21a.. Contact deposits in sandstone at its junction with diabase. These include the New Jersey ores vigorously worked before the Revolution. They consist of the carbonates, cuprite and native copper disseminated through the sandstone near the trap.

The Schuyler Mines near Arlington N.J. and numerous other openings near New Brunswick are the best known. These Triassic diabases often show chalcopyrite and it is probable that the copper came from this or from copper in the augite of the rock in accordance with Sandbergers investigations.

Type 21b.. Contact deposits in sandstone at the junction with gneiss. A number of deposits were formerly worked of this character,

the granite. Copper is known elsewhere in sandstones, and the Lake Superior conglomerates (See Type 13) where it has been reduced to the metallic state are of interest in this connection.

(Note). There are numerous other copper districts in Arizona of minor importance or entirely undeveloped, but the types above cited probably illustrate the occurrences quite fully. Mention should be made also of the mines in Nevada County, California, opposite Gunpowder.

Blake W.P. The Copper Deposits of Copper Basin Arizona. M.E. May.47?
E. & M. Jour. Arizona Copper & Copper Mines Aug. 13 1881 p. 103
" " The Clifton Copper Mines Arizona. Feb 21. 1880 p. 133.
" " The Globe Dist. April 9 1881 p.248.
Henrich C. The Copper Ore Deposits near Morenci Arizona E. & M. Jour.
March 26. 1887. p.205.
Tafford A. Occurrences of Gold and Silver in Oxidized Copper Ores in Arizona. E. & M. Jour. June 16 1888. 455.
Wendt A F. Copper Deposits of the Southwest. M.E. 15-25 also condensed in the E. & M. Jour. Feb. 5. 1887 and in subs. No. Mexico
Mexicana. Santa Rita Mines Mexico of a Tour in Northern Mexico
" " page 47. (Historical).

Type 20g. Wyoming. Oxidized Ores are found at the Sunrise Mine in the Laramie Range and some copper has been produced.

Type 20h. Oreamon Mammoth, Utah. Sugarest vein in dolomitic limestone carrying copper, gold and silver ores. In the Tintic district 70 miles south west of Salt Lake City, are a number of veins which produce considerable copper as necessary to the precious metals. The veins, or belts are of great width and afford rich silver or chimneys amid much low grade ore or gangue. They will be referred to again under the precious metals.

Huntley D.B. 10th Census Vol. 15 p. 656.
Hollister O.J. Gold and Silver Mining in Utah. M.E. 16 p 10.

Type 21. Copper Ores in Triassic Sandstone. Oxidized ores native copper and chalcocite in contact deposits in Triassic sandstones at their junction with diabase or gneiss or as disseminated masses replacing organic remains. Copper ores are very common throughout the estuary Triassic rocks of the Atlantic coast and although formerly much mined are now proved valueless, and only of scientific interest.

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Type 21b. Contact deposits in sandstone at the junction with [illegible] A number of deposits were formerly worked of this character

Whitney.J.D. On the Black oxide of Copper L. Superior Proc. Boston Society of Natural History Jan 1849 p. 10".
" Metallic Wealth U.S. p.245 Rec.
Whittlesey C. On the Electrical Deposition A.A.A.S. 24.60.
Wright C.E. and Lawton C.D. Mineral Statistics of Mich. Annual.

Type 19.. St. Genevieve Mo.. Beds of chalcopyrite associated with chert in magnesian limestone of the Lower Silurian System. There are two beds at St. Genevieve, of widths varying between 3" and several feet . They lie between chert seams and are associated with clay and sand. The limestone containing the ore bodies is the 2nd Magnesian of the Mo. geologists. The ore is thought by Nicholson to have been deposited by dolomitization etc. as have the lead and zinc deposits of south west Mo. and as is described under Type 25.

Nicholson F.A Review of the St. Genevieve Copper Dist. M.E. 10.444.
Shumard B.F. Observations on the Geology of the Co. of St. Genevieve Mo. Trans. St.Louis Acad. Sci. Vol. I p.40 Abstract in A.J.S. II. 29. 126.

Type 20. Arizona. Ore bodies of oxidized Copper ores, in Carboniferous limestones associated with eruptive rocks. In addition to these which are the most important, veins in eruptive rocks or in sandstones or ore bodies of still different character as set forth under the different subtypes. (The following descriptions come chiefly from Wendt. l.c.) The Copper districts are nearly all in the south eastern part of the state, only the Black Range being about the center.

Type 20a.. Clifton. The Clifton District lies in a basin 6-10 miles across, whose high surrounding hills consist of Carboniferous limestone, resting on sandstone and this on granite. In the basin is a great eruptive mass of porphyry often with immense inclusions of limestone. Felsite dikes are abundant. There is also an outflow of late trachyte. From this it appears that eruptive phenomena are very abundant.

1. Ores in limestone. Veins of irregular character, probably originating along fissures (?) but afterwards dissolved out into irregular cavities, (Longfellow) or else along the contact between intrusive dikes and limestone (Detroit). The ore is a copper bearing wad running as high as 20 % Cu. in quantity. Great bodies of clay are also present in close association with the ore. These deposits seem to be quite analogous to those at Leadville. (Type32)

2..Ores in porphyry. Narrow stringers in porphyry above, joining to a single vein below (Metcalf) or a fissure vein in a large porphyry dike (Coronado) . Chalcocite is the principal ore running into chalcopyrite below.

3..Ores in Granite. Chalcocite in fissure veins. These are less developed. The ore bodies in limestone, here as elsewhere in Arizona are the most productive.

Type 20b. Bisbee Dist. Oxidized ores deposited along the bed -

Whitney, J.D. On the Black oxide of Copper I. Superior Proc. Boste
Society of Natural History Jan 1852 p. 10".
Metallic Wealth U.S. p.245 Rep.
White Sleeve C. On the Electrical Deposition A.A.A.S. 24.60.
Wright C.R. and Lewton C.D. Mineral Statistics of Mich. Annual
Type 19., St. Genevieve Mo.. Beds of chalcopyrite associated
with chert in magnesian limestone of the lower Silurian System;
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2nd Magnesian of the Mo. geologists. The ore is thought by Nichol
son to have been deposited by dolomitization etc. as have the lea
and zinc deposits of south west Mo. and as is described under Typ
25.
Nicholson P.A Review of the St. Genevieve Copper Dist. M.E. 10.44
Shumard B.F. Observations on the Geology of the Co. of St. Genevi
eve Mo. Trans. St.Louis Acad. Sci. Vol. I p.40 Abstract
in A.J.S. II. 29. 128.

Type 20. Arizona. Ore bodies of oxidized Copper ores, in Qua
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to these which are the most important, veins in eruptive rocks or
in sandstones or ore bodies of still different character as set
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in the south eastern part of the state, only the Black Range being
about the center.

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into chalcopyrite below.
3..Ores in Granite, Chalcocite in fissure veins. These are lea
developed. The ore bodies in limestone, here as elsewhere in Ari
zona are the most productive.
Type 20b. Bisbee Dist. Oxidized ores deposited along the bed

ng planes and joints of Carboniferous limestone which has been placed or dissolved out to form great cavities, so that the ore ies appear at times to be cave fillings. Eruptive porphyry is undant in the neighborhood. Wendt thinks that the ores have been posited directly as oxidized ores, not having been sulphur com- unds ever in situ. The Copper Queen is the principal mine. her deposits chiefly chalcopyrite above and chalcopyrite below e known in the porphyry but not worked. (cf. 20a).

Type 20b. Globe dist. 1..Oxidized ores deposited in Carboniferous limestone along or very near its contact with eruptive diorite, d with trachyte near.(Globe Mine).

2..Fissure veins in sandstone containing arsenical and antimonal copper ores (Old Dominion Mine).

3..Fissure veins in talcose slate and gneiss filled by a quartz ngue containing carbonate ores.(N.Y. & Chicago Mines).

4.. Numerous small veinlets forming a stockwerk in gneiss near dike of diorite. A dike of trachyte is also near. (Black Copper oup too low grade for profitable working).

5.. Beds of Chrysocolla just below the surface in the superfial debris or wash. They appear to have been deposited by the rface drainage from the stockwerk up the hill.(Cf. also Type 1a d 1b.).

Type 20d.. Santa Rita Dist. 1..Native copper below, changing to prite above, disseminated in pellets in an eruptive felsite (Cf. pe 19. Lake Superior Amygdaloids).

2..Contact deposits of oxidized ores along the contact of the lsite and the neighboring limestone.

Type 20e. Black Range Dist.. Contact deposits of oxidized ores ove, descending into sulphides below, in slates along their conct with a dike of porphyrite and running into it. Carboniferous mestones are near, and are pierced by numerous great dikes of eenstone, but afford no ores. The principal mines of the district e the Hampton and Eureka.

All the Arizona deposits except the chrysocolla (Type 20e.5) e referred by Wendt to fissure veins, a conception that it is ten difficult to form from his subsequent descriptions, especially r the limestone deposits. The invariable association of eruptive cks are significant and it seems that these eruptive phenomena t up an extraordinary circulation of copper bearing solutions at date subsequent to Carboniferous times (Cf.Leadville Type 32). It would appear as if the contact deposits may be more or less ferred to an origin by replacement.

Type 20f. Copper Basin. Beds of losely textured conglomerate d sandstone resting on granite and gniess, with a cement of pper carbonates. The granites are greatly decomposed and it is ought by Blake that the copper has leached out from these as lphate and been deposited then in the sedimentary beds as carbone. Many small veinlets and pellets of copper ore are found in

especially at Bristol Conn. (Chalcocite in fine crystals) and at the Perkiomen Mine Penn.. The ores were both oxidized and sulphides and in both these places were associated with barite. Other related veins contain lead (See Type 22a (3) under lead).

Beck L.C. Notice of the Native Copper, Ores of Copper etc. near New Brunswick New Jersey. A.J.S. I. 36 107.

Cook G.H. Geology of N.J. 1868 p.675. Also L.C.Beck 218-224.

Shaeffer C.A. Native Silver in N.J. Copper Ore. E.& M.J.Feb.'82 p.90

Silliman B. & Whitney J.D. Notice of the Geol. Position and character of the Copper Mine at Bristol Conn. A.J.S.II.20. 361.

Whitney J.D. Metalic Wealth. Rec.

Type 21c.. Chalcocite and copper carbonates, replacing vegetable remains etc., in the Triassic aandstones of Texas, New Mexico and Utah. At various places in the above states (Abiquiu N.M. Silver Reef,Utah) the sandstones as reported by Newbarry, and others have disseminated through them copper ores deposited on fossils and at times with associated silver(Utah). The copper whether coming from the waters along the shore line, or from subterranean currents was precipitated by the organic matter (See also under Silver).

These deposits are not yet sources of copper.

Cazin F.M.F. The Origin of Copper and Silver Ores in Triassic Sand Rock. E & M.Jour. Dec.11,1880 p.381. April 30 1881.

E.& M.Jour. The Nacemiento Copper Deposits.Aug.22 1885. p.124.

Jackson,A.W. Rep't of Director of the Mint. 1880 p.384.

Newberry,J.S. Copper in Utah Triassic Sandstones E.& M.Jour. Vol XXXI p.5. Also Oct.23.'80 p.269 Jan.1,1881 p.4 See also 10th Census,Vol.XIII,Precious Metals pp. 40 & 478.

Rolker,C.M. The Silver Sandstone Dist. of Utah M.E. 9. 21.

Rothwell,R.P. Quoted in 10th Census,Vol.XIII p.478.

Silliman B. The Mineral Regions of Southern New Mexico M.E. 16.427.

Copper Production in Tons.

	1850	1860	1870	1880	1885	1887	1888
Atlantic Coast	78	1800			221	100	
Lake Superior.	5740	5300	10900	22200	36074	37.735,	43292
Missouri				115		M.M. 815	
Arizona & N.M.					11393	9001	15748
Utah.				63	1250		1660
Montana.				33 899	39 350		48949
California.				234	800		785
Wyoming. (1882. 50. 1883.481).							Col. 1650
Other Sources						12 18	1621
Total U.S.Sh.tons	6500	7100	12500	30375	82.937	90.460	113926
" Long tons.				27000	74.053	80.768	
Total Europe				59370	76.258	79.244	
Other Foreign Sources.				68405	75326	64300	

especially at Bristol Comm. (Chalcocite in fine crystals) and at the Parkinson Mine Penn.. The ores were both oxidized and sulphides and in both these places were associated with barite. Other related veins contain lead (See Type 22a (3) under lead).

Beck L.G. Notice of the Native Copper, Ores of Copper etc. near New Brunswick New Jersey. A.J.S. I. 36 107.

Cook G.H. Geology of N.J. 1868 p.672. Also L.G.Beck 218-224.

Chester C.A. Native Silver in N.Y. Copper Ore. E.& M.J. Feb.

Silliman B. & Whitney J.D. Notice of the Geol. Position and character of the Copper Mine at Bristol Comm.. A.J.S. II 20. 361.

Whitney J.D. Metallic Wealth. Rec.

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These deposits are not yet sources of copper.

Dana J.M.& J. The Origin of Copper and Silver Ores in Triassic Sand Rock. E & M.Jour. Dec.13,1884 p.381. April 30 1887.

E.& M.Jour. The Nacemiento Copper Deposits.Aug.22 1885. p.124.

Jackson,A.W. Rep't of Director of the Mint. 1880 p.384.

Newberry,J.S. Copper in Utah Triassic Sandstones E.& M.Jour. Vol XXXI p.5. Also Oct.25.'80 p.269 Jan.1.1881 p.4 See also 10th Census,Vol.XIII,Precious Metals pp. 40 & 478.

Rolker,C.M. The Silver Sandstone Dist. of Utah M.E. 9. 21.

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Atlantic Coast	78	1800			221	100	
Lake Superior.	5760	5300	10900	22200	36074	37 785	
Missouri			118				
Arizona & N.M.					11393	9001	
Utah.				63	1850		
Montana.				33 899	39 850		
California.				254	800		
Wyoming. (1882., 50. 1883,481).							
Other Sources						18 18	
Total U.S.Bn.tons8500		7100	- 12800	30375	82.937	90 460	
" Long tons.				27000	74.052	80 768	
Total Europe				59370	76.868	79 244	
Other Foreign Sources.				68405	75324	64300	

Lead Series.		Pb.	S.
Galena.	Pb S.	86.6	13.4
Cerussite.	$PbCO_3$	77.5	
Anglesite.	$PbSO_4$	67.7	
Pyromorphite.	$Pb_3P_2O_8 + 1/3\ PbCl_2$	76.3	

Earthy mixtures of these last and limonite.

Type 22. Atlantic Border. Veins of galena, in the Archaean of the States along the Atlantic border; also others in the Palaeozoic as described in the subtypes.

Type 22a. Veins in gneiss and crystalline limestone, sometimes with a batite or calcite gangue. These deposits were vigorously exploited forty years ago or more but have since been of small importance other than scientific. They may be best described by districts as they hardly deserve greater prominence.

1. St. Lawrence Co. N.Y. Veins with galena in a gangue of calcite in Archaean gneiss. Those near Rossie are perhaps best known especially for their unusually interesting calcite crystals. There are numbers of veins in the district which are notable in that the galena is without zinc or iron associates. It carries a very small amount of silver, not enough to separate. Hornblende and mica schists occur in the same region and the Potsdam sandstone is not far removed.

Beck. L.C. Mineralogy of New York.
Emmons. E. Geology of the Second Dist. New York Geol. Survey.
Whitney J.D. Metallic Wealth, Rec.

2. Mass. Conn. and Eastern New York. Veins of galena with more or less chalcopyrite and pyrite in a quartz gangue in gneiss, slates, limestone and mica schist. The mines near Northampton were formerly well known although never producing a great deal of metal, but as this is a large prominent vein it attracted attention. There are numerous others in the same region. Also in Conn. at Middletown where much silver is said to have been found in the galena. More recently (circa 1873) at Newburyport Mass. argentiferous galena attracted attention but was not of any importance. Other veins are known at Lubeck in Me. and various parts of N.H. and Vt.. For a while small lodes in the slates in Columbia Co. were unsuccessfully exploited and the Ancram Mine is of historic interest. Although these galena veins are numerous they must not be taken too seriously.

3. S.E. Penn. Veins on the contact of Archaean gneiss and Triassic sandstone and diabase. These were referred to under copper (Type 21b). As noted by Whitney the copper is especially strong in the sandstone and the lead in the gneiss. Trap dikes are abundant and the eruptive phemomena in connection with them doubtless occasioned the activity of circulation which filled the veins. The Wheatley mine is the best known, affording a great variety of lead minerals, especially pyromorphite. They have not been worked in years.

Lead Series.

		Pb.	S.
Galena.	Pb S.	86.6	13.4
Cerussite.	$PbCO_3$	77.5	
Anglesite.	$PbSO_4$	68.3	
Pyromorphite.	$Pb_5P_2O_8+1/3\ PbCl_2$	76.3	

Earthy mixtures of these last and Limonite.

Type 25. Atlantic Border. Veins of galena, in the Archaean of the States along the Atlantic border; also others in the Palaeozoic as described in the subtypes.

Type 25a. Veins in gneiss and crystalline limestone, sometimes with a barite or calcite gangue. These deposits were vigorously exploited forty years ago or more but have since been of small importance other than scientific. They may be best described by districts as they hardly deserve greater prominence.

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Beck. A.G. Mineralogy of New York.
Emmons.E. Geology of the Second Dist. New York Geol. Survey.
Whitney J.D. Metallic Wealth. Rec.

2. Mass. Conn. and Eastern New York. Veins of galena with more or less chalcopyrite and pyrite in a quartz gangue in gneiss, slates, limestone and mica schist. The mines near Northampton were formerly well known although never producing a great deal of metal, but as this is a large prominent vein it attracted attention. There are numerous others in the same region. Also in Conn. at Middletown where much silver is said to have been found in the galena. More recently (since 1873) at Newbury Vport Mass. argentiferous galena attracted attention but was not of any importance. Other veins are known at Lubeck in Me. and various parts of N.H. and Vt. For a while small lodes in the slates in Columbia Co. were successfully exploited and the Ancram Mine is of historic interest. Although these galena veins are numerous they must not be taken too seriously.

3. S.E. Penn. Veins on the contact of Archaean gneiss and Triassic sandstone and diabase. These were referred to under copper (Type 21b). As noted by Whitney the copper is especially strong in the sandstone and the lead in the gneiss. Trap dikes are abundant and the eruptive phenomena in connection with them doubtless occasioned the activity of circulation which filled the veins. The Wheatley mine is the best known, affording a great variety of lead minerals, especially pyromorphite. They have not been worked in years.

4. Davidson Co. N.C. Veins in talcose slate. Formerly exploited but now little known except as having furnished beautiful crystals of oxidized lead minerals.

Geological Reports of the Various States.

Lee C.A. Notice of the Ancram Lead Mines. A.J.S. I. 8. 247.
Nash A. Notice of the Lead Mines and Veins in Hampshire Co. Mass. A.J.S. I. 12. 238.
Richards R.H. The Newburyport Silver Mines. M.E. 3. 442.
Whitney. Metallic Wealth U.S.

Type 22a. Sullivan and Ulster Co,s. N.Y. Veins along a line of displacement on the contact between the Hudson River Slates and sandstones of the Medina Stage (Shawangunk Grit) carrying galena and chalcopyrite in a quartz gangue, or else gash veins filled with the same, in the Grit. These mines formerly produced considerable lead and copper but are now best known for the excellent quartz crystals which they have furnished to all the mineralogical collections of the land.
Whitney J.D. Metallic Wealth and the N.Y. State Reports.

Type 23. Bonne Terre Mo. Galena accompanied by nickeliferous pyrite, disseminated through beds of the Third or Lower Magnesian Limestone (Lower Silurian System) of the Mo. geologists. The mines are at Bonneterre, Mine la Motte and Doe Run 25 miles west of the Miss. River and 40 to 100 miles south of St. Louis. The strata lie almost horizontal and are known to carry lead through over 200' in thickness. The rich places fade out into barren rock and appear to be local enrichments of the limestone, of which the galena forms an integral part. No zinc whatever occurs with the lead and the silver contents are very small. At Mine la Motte some copper is found and much more nickel and cobalt, including siegenite, a variety of linnæite, which impregnates a sandstone supposed to be Potsdam. All the ore bodies are crossed by small faults near which they are invariably barren. Knobs of Archaean granite and diabase dikes crop out near the mines both at Mine la Motte and Doe Run.

The ore is thought by the writer to have been deposited together with the limestones, probably by decaying vegetable tissues (Cf. Type 24) on the bottom of the Lower Silurian Sea, as suggested by Whitney for other but totally different deposits.

The whole region of Lower Silurian rocks, over nearly 3000 sq. miles contains lead. These disseminated deposits are in no way to be confused with the gash veins, with which they have nothing in common. They are now large producers of lead and the only mines worked in the U.S. for lead alone. Except at Mine la Motte lead was also obtained from this region, previously to 1865 from small gash veins like those of Type 24. but the workings were never commensurate with the present disseminated mines. Historical description.

Broadhead G.C. The Southeastern Mo. Lead Dist. M.E. 5. 100.

Gage J.R. On the Occurrence of Lead Ores in Mo. M.E. 3. 116.
Geological Survey of Mo. 1873-74 pp. 30 and 603.
Kemp J.F. Notes on the Ore Deposits etc. in S.E.Mo. S. of M. Quarterly. Oct. 1887. Rec.

Several other papers have been published on the metallurgical treatment and ore dressing in the M.E. or Quarterly.

In1887 Colorado produced much more lead than any other State, Utah second, Idaho third, Missouri fourth, and Montana fifth.

Lead Production (Short tons).

	1850.	1860.	1870.	1875.	1880.	1885.	1887.	1889.
Atlantic Coast.						250		
Miss.River Dist.	17700.			5000				
S.E.Missouri				17000		21600		34000
S.W.Missouri							8687	
Utah						27159	22838	22000
Nevada					10659	3500	3400	1500
Colorado							74815	70000
New Mexico							8000	
Montana							8779	
Idaho							20000	30000
California & Arizona							800	1500
Dakota							1000	
Elsewhere								31000
England				57400	56900	37600		
Germany	13000	28000	55000	69900	88800	92400		
Spain								
Other Countries								
Total U.S.							160700	190000
Total Foreign								

Cf. Mineral Resources U.S. 1885 & 1887. The U.S. produces more lead than any other single country. Of the product in 1887 84.3 % came from lead-silver ores. The figures for 1889 are from the E.& M. Jour. Jan. 4th 1890

LEAD AND ZINC.

Type 24..Upper Miss. Valley Gash Veins. Gash veins, or fissures limited to a single limestone formation (the Galena of the Trenton Stage) containing galena, zinc-blende and pyrite (Marcasite) with calcite and residual clay. The deposits are found in S.W.Wis. N.E.Ia. and N.W.Ill., and similar deposits but of earlier geological age were formerly wrought in S.E.Mo.. The Galena limestone reaches a thickness of 200' of which the middle 100' is the portion richest in lead. The ore occurs in limited fissures supposed by Whitney to have been formed by the drying and consolidation of the limestone, i.e. to be joints, but since referred by Chamberlain to gentle oscillations of the rocks and to the summits of anticlines and the bottoms of synclines. The cavities have been enlarged by water and are often partly filled by residual clay. The ores also

Page J.B. On the Occurrence of Lead Ores in Mo. M.E. 5. 118.
Geological Survey of Mo. 1873-74 pp. 39 and 608.
Kemp J.F. Notes on the Ore Deposits etc. in S.E.Mo. S. of M.
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Lead Production (Short tons).

	1850,	1860.	1870.	1875.	1880.	1885.	1887.	1889.
Atlantic Coast.					250			
Miss.River Dist.			17700.		8000			
S.E.Missouri					17000	21800		34000
S.W.Missouri							8887	
Utah						27159	22858	22000
Nevada						10859	3400	1800
Colorado							7483	10000
New Mexico							8000	
Montana.							8779	
Idaho							20000	30000
California & Arizona							800	1800
Dakota							1000	
Elsewhere								31000
England					8740	3690	3760	
Germany				1300	2800	3600	6990	8800	9240	
Spain								
Other Countries								
Total U.S.								165700
Total Foreign								

Cf. Mineral Resources U.S. 1885 & 1887. The U.S. produces more lead than any other single country. Of the product in 1887 84.5 % came from lead-silver ores. The figures for 1889 are from the M.& M. Jour. Jan. 4th 1890

LEAD AND ZINC.

Type 2A. Upper Miss. Valley Vein, Bank Veins, or Flanges limited to a single Limestone formation (the Galena of the Trenton Stage) containing galena, zinc-blende and pyrite (Marcasite with calcite and residual clay. The deposits are found in S.W.Wis. S.E.Ia. and N.W.Ill., and similar deposits but of earlier geological age were formerly wrought in S.E.Mo.. The Galena limestone reaches a thickness of 200' of which the middle 100' is the portion richest in lead. The ore occurs in limited flanges supposed by Whitney to have been formed by the drying and consolidation of the limestone, i.e. to be joints, but since referred by Chamberlain to gentle oscillations of the rocks and to the summits of anticlines and the bottoms of synclines. The cavities have been enlarged by water and are often partially filled by residual clay. The ores also

occur in horizontal cavities along the bedding planes. Chamberlain makes eleven different kinds of openings, but that is an over-refinement. They form stalactites or wall-coatings or scattered lumps on the floor. J.D.Whitney argued that the galena of these deposits was precipitated from oceanic solution by the sulphuretted gases arising from decaying organic matter and in this way were deposited either directly in the cavities or sparsely throughout the limestone and later segregated. Chamberlain has traced a series of Silurian oceanic currents with something of a Sargasso Sea in the lead region which precipitated the lead etc. in depressions of the bottom and later it was buried in the rocks and leached into the cavities and precipitated by sulphurous exhalations from lower bituminous strata.

Chamberlain T.C. Wis. Geol.Survey. Vol. IV p.367. 1882 Rec.
Daniels E. Wis. Rep. 1854.
E.& M.Jour. The Lead Region of Wis. July 6.13.20.27. Aug. 3.10.24 Oct. 5, 1878.
Litton.A. 2nd. Annual Rep. Mo. Geol. Survey 1854.
Owen D.D. U.S. Senate Documents 1844.
Percival J.G. Wis. Report. 1856.
Shaw J. Ill. Geol. Survey Vol. II. p. 40. 1873.
Strong M. Wis. Grol. Survey .Vol. II p. 689. 1877.
White C.A. Ia. Geol. Survey. Vol. II. p.339. 1870.
Whitney J.D. Metallic Wealth p. 403. 1856
" Ia. Geol. Report Vol. I.p. 22. 1858.
" Wis Geol. Survey 1861.62 Vol.I p.221. Rec.
" Ill. Geol. Survey Vol. I. p. 153 1866.

Type 25. South west Mo.. Galena, zinc blende and pyrite with their oxidized products associated with chert, residual clay, calcite and asphalt in cavities of irregular shape in Subcarboniferous strata. The ores occur principally in Jasper and Newton Co,s Mo. and to a less degree in the adjoining portions of Ark. and Kansas. Joplin and Granby Mo. are the chief centers. The ore bodies are limited to about 150' of interbedded chert and limestone and an intermediate rock called by Schmidt silico-calcite. The ores cement together fragments of these into a sort of breccia, and are also found in cavities between the large fragments, the whole mass appearing as if shattered or rendered cellular by some process previously to the ore deposition. A Schmidt, and A Leonhard explained them in a very able way by the well known theory of "dolomitization" (see also under Natural Gas). Schmidt traces six periods in the history of the deposits. 1..Period of rock formation. 2..Period of consolidation with formation of joints. 3..Period of dolomitization from the joints outward, of shrinkage and of ore deposition as sulphides. 4..Period of solution and removal of calcite from certain strata and continued deposition of ores. 5..Introduction of quartz and alteration of blende to calamine. 6..Period of oxi-

occur in horizontal cavities along the bedding planes. Chamberlain makes eleven different kinds of openings, but they may be an over-refinement. They form stalactites or wall-coatings or scattered lumps on the floor. T.C.Whitney argued that the galena of these deposits was precipitated from oceanic solution by the sulphuretted gases arising from decaying organic matter and in this way were deposited either directly in the cavities or sparsely throughout the limestone and later segregated. Chamberlain has traced a series of Silurian oceanic currents with something of a Sargasso Sea in the lead region which precipitated the lead ore. In depressions of the bottom and later it was buried in the rocks and leached into the cavities and precipitated by sulphurous exhalations from lower bituminous strata.

Chamberlain T.C. Wis. Geol.Survey. Vol. IV p.387. 1903 Rec.
Daniels E. Wis. Rep. 1853.
T.& M.Jour. The Lead Region of Wis. July 6.13.20.27. Aug. 3.10.24 Oct. 5. 1872.
Litton.A. 2nd. Annual Rep. No. Geol. Survey 1854.
Owen D.D. U.S. Senate Documents 1844.
Percival J.G. Wis. Report. 1839.
Shaw J. III. Geol. Survey Vol. II. p. "40. 1879.
Strong M. Wis. Geol. Survey .Vol. II. p. 689. 1877.
White C.A. Ia. Geol. Survey. Vol. II. p.320. 1870.
Whitney J.D. Metallic Wealth p. 402. 1854.
" Ia. Geol. Report Vol. I.p. 422. 1858.
" Wis Geol. Survey 1903 Vol.I p.381. Rec.
" III. Geol. Survey Vol. I. p. 185 1835.

Type 25. South west Mo.- Quincy, zinc blende and pyrite with their oxidized products associated with chert, residual clay, sandstone and asphalt in cavities of irregular shape in Subcarboniferous strata. The ores occur principally in Jasper and Newton Co.s Mo. and to a less degree in the adjoining portions of Ark. and Kansas. Joplin and Granby Mo. are the chief centers. The ore bodies are limited to about 150' of interbedded chert and limestone and an immediate rock called by Missouri miners-cotlite. The ores consist together fragments of these into a sort of breccia, and are also found in cavities between the large fragments, the whole mass appearing as if cemented or rendered coherent by some process previously to the ore deposition. A Missouri, and A Leonhard explain them in a very able way by the well known theory of "dolomitization" (see also under Natural Gas). Schmidt traces six periods in the history of the deposits. 1..Period of rock formation. 2..Period of consolidation with formation of joints. 3..Period of dolomitization when the joints enlarged, of shrinkage and of ore deposition as sulphides. 4..Period of solution and removal of calcite from certain strata and continued deposition of ores. 5..Introduction of quartz and alteration of blende to galenite. 6..Period of mul-

dation of sulphides. (Views and Sections). The newly reorganized Mo. Geol. Survey is now devoting attention to this region.

Note. Other lead deposits are known in central Mo. generally resembling the above quite strongly but of less economic importance Some however are described by Schmidt as conical stockwerks.

Clerc.F.L. Zinc in the U.S. Mineral Res. 1882. p.368. E.& M. Jour. Sep. 8. 1883 p.148.

" Study of the S.W. Mo. Deposits . E.& M.Jour.June 4.'87p397.

Eng. & Min. Jour. Nov. 3. 1888 p.369. Plan of the Granby Mine. Also March 8. 1890 p. 286.

Haworth E. A Contribution to the Geology of the Lead and Zinc Mining Dist. of Cherokee Co. Kan. Oskaloosa Ia. 1884.

Raymond R.W.Note on the Zinc Dep. of Southern Mo.M.E. 8. 165. E.& M. Jour. Oct. 4. 1879.

Schmidt A. and Leonhard A. Mo. Geol. Survey. 1874. p. 384.Rec.

Schmidt A. Die Blei-und Zink Erlagerstätten von Sudwest Missouri. Heidelberg 1876. Rec.

Seamon W.H. Zinciferous Clays of S.W.Mo. etc. A.J.S. III 39-38.

Note. Both the mines of Type 25 and those of Type 24 were originally worked for lead, and the zinc minerals were regarded as a nuisance; of late years the zinc has been rather more of an object than the lead. The deposits in south west Va. (Type 28) also produce lead but are best known for zinc.

ZINC SERIES.

		Zn	S	Fe	SiO	Mn
Sphalerite (Commonly called Blende)	ZnS.	67	33			
Zincite	ZnO	803				
Franklinite	(Fe Zn Mn) O $(Fe Mn.)_2O_3$	554		51.8		785
Willemite	$2ZnO.SiO_2$	58.5			27.1	
Calamine	$2ZnO.SiO_2 H_2O.$	54.2			25.0	
Smithsonite	$ZnOCO_2$	51.9				

Clerc F.L. Zinc in the U.S. Min. Res. 1882. p.358.

Type 24.Upper Miss. Valley Gash Veins. See p. 37 under Lead.
Type 25.S.W. Mo. See p. 38 under Lead.

Type 26. Saucon Valley Pa. Zinc blende and its oxidation products, calamine and smithsonite filling innumerable cracks and fissures in a disturbed magnesian limestone thought to belong to the Chazy Stage. The ore bodies occur in the Saucon Valley, near the town of Friedensville about four miles from Bethlehem Penn.. The limestone has apparently been shattered by the elevation of the neighboring South Mtn. and in the cavities thus formed along an anticline the zinc ores were deposited. The ore follows the bedding planes and the joints normal to these throughout a zone varying from 10' to 40'. The oxidized ores were near the surface the blende below. The blende is a peculiar variety that resembles a greenish flint. A little pyrite occurred with it. The mines were

dation of sulphides. (Views and Descriptions). The newly reorganized Mo. Geol. Survey is now carrying attention to this region.

Note. Other lead deposits are known in central Mo. generally resembling the above quite strongly but of less economic importance Some however are described by Schmidt as con. cal stockworks.

Cleve. J.L. Zinc in the U.S. Mineral Ind. 1896. p.388. E.& M. Jour. Sep. 8. 1883 p.168.

" Study of the S.W. Mo. Deposits . E.& M.Jour.June 6.1896 p.
Eng. & Min. Jour. Nov. 8. 1888 p.389. Plan of the Granby Mine.

Also March 8. 1890 p. 286.

Haworth.E. A Contribution to the Geology of the Lead and Zinc Mining Dist. of Cherokee Co. Kan. Oxzaloosa Ia. 1894.

Raymond R.W.Note on the Zinc Dep. of Southern Mo.M.E. 8. 185. E.& M. Jour. Oct. 6. 1879.

Schmidt A. and Leonhard A. Mo. Geol. Survey. 1874. pp 384.Pee.

Schmidt A: Die Blei-und Zink Erzlagerstätten von Südwest Missouri, Heidelberg 1876. Pee.

Seamon W.H. Zinciferous Clays of S.W.Mo. etc. A.J.S. III 29-38.

Note. Both the mines of Type 28 and those of Type 26 were originally worked for lead, and the zinc minerals were regarded as a nuisance; of late years the zinc has been rather more of an object than the lead. The deposits in south west Va. (Type 28) also produce lead but are best known for zinc.

ZINC SERIES.

	Zn	S	Fe	CO	Mn
Sphalerite (Commonly called Blende)	ZnS.	67	33		
Zincite	ZnO	80%			
Franklinite	(Fe Zn Mn) O ($Fe Mn)_2O_3$	15%		21.9	7%
Willemite	$2ZnO.SiO_2$	27%			27.1
Calamine	$2ZnO.SiO_2 H_2O.$	54.2			25.0
Smithsonite	$ZnCO_3$	64.8			

Geol. Surv. Ill. Zinc in the U.S. Min. Res. 1882. p.352.
Type 24. Upper Mine. Valley Dam Veins. See p. 17 under Lead.
Type 25. S.W. Mo. See p. 25 under Lead.

Type 26. Saxona Valley Va. Zinc blende and its oxidation products, calamine and smithsonite filling innumerable crevis and fissures in a disturbed magnesian limestone thought to belong to the Clinch Stage. The ore bodies occur in the Saxon Valley, near the town of Friedensville about four miles from Bethlehem Penn.. The limestone has apparently been shattered by the elevation of the neighboring South Mts. and in the cavities thus formed along an anticline the zinc ores were deposited. The ore follows the bedding planes and the joints normal to these throughout a zone varying from 10' to 60'. The oxidized ores were near the surface the blende below. The blende is a peculiar variety that resembles a greenish flint. A little pyrite occurred with it. The mining were

very wet. Although strong producers from 1853 to 1876, since the latter date the mines have been but little worked. The ore is thought by Drinker to have been concentrated in the cavities from a disseminated condition in the limestone.

Clerc F.L. Min. Resources. 1882. 361. Rec.
Drinker H.S. On the Mines and Works of the Lehigh Zinc Co. M.E.1.67.
Hall C.E. in Rept. D3. 2nd Geol. Survey. Penn. p.239.

Type 27. S.W. Virginia. Veins or beds of oxidized ores probably changing to blende below in crystalline limestone or dolomite just above the Calciferous but as yet not sharply determined. The ore-bearing terrane is known over a considerable extent of country, running from near Roanoke west 100 miles. The largest mines are in Wythe Co. to the west and others of great promise have lately been opened near Roanoke. According to Boyd these ores are at one place 486' of strata impregnated with lead and zinc in varying amounts. The ore bodies are at times of great size (40' wide) and are associated with more or less of lead minerals and iron pyrites.

The descriptions thus far published do not give a very definite idea of the character of the ore body doubtless because it is itself irregular but it would appear as if the region must become an important producer of zinc.

Boyd.C.R. Resources of S.W. Va. p.71.
" Mineral Wealth S.W. Va. M.E.5-81.
" Mineral Resources S.W. Va. M.E. 8. 340. Rec.
Dewey F.P. Note on the Falling Cliff Zinc Mine. M.E. 10. 111.

Type 28. Franklin and Sterling N.J. A bed consisting of franklinite, willemite, zincite etc. in Calcite, in Archaean crystalline limestone, analogous to the Magnetic beds of Type 13. At Franklin Furnace and Sterling, towns about 5 miles apart in Northwestern N.J. is found an extended belt of crystalline limestone and in it these two unique beds. At Franklin the ore body is three quarters of a mile long and bends around an S shaped synclinal two of whose sides are folded together and that has afterwards been tilted. Trap dikes intersect it. The bed varies somewhat but consists essentially of crystals of franklinite (approximating O and ∞O) thickly set in a matrix of zincite, willemite and calcite.

In the same limestone magnetite lenses have also been found. At Sterling there are two beds outcroping on a hillside with a depression in the country rock between them from which a great quantity of calamine was formerly extracted. (Views and Sections).

The ores are also an important source of manganese.

These deposits are entirely unique and a hard problem as regards origin. On the analogy of magnetite they may have been a zinc-manganese bog ore bed which was later metamorphosed to the present minerals.

Alger F. On the Zinc Mines of Franklin Sussex Co. N.J. A.J.S.I 48 258.

Type 27. S.W.Virginia. Veins or beds of oxidized ores probably changing to blends below in crystalline limestone or dolomite just above the Cambrian-Ore but as yet not sharply determined. The ore-bearing terrane is known over a considerable extent of country, running from near Roanoke west 100 miles. The largest mines are in Wythe Co. to the west and others of great promise have lately been opened near Roanoke. According to Boyd these ores are at one place 450' of strata impregnated with lead and zinc in varying amounts. The ore bodies are at times of great size (40' wide) and are associated with more or less of lead minerals and iron pyrites.

The descriptions thus far published do not give a very definite idea of the character of the ore bodies because it is itself irregular but it would appear as if the regions must become an important producer of zinc.

Boyd.U.S. Resources of S.W. Va. p.71.
" Mineral Wealth S.W. Va. M.E.Dec31.
" Mineral Resources S.W. Va. M.E. 8. 560. Nov.
Berry T.P. Note on the Rolling Cliff Zinc Mine. M.E. 10. 118.

Type 28. Franklin and Sterling N.J. A bed containing of franklinite, willemite, zincite etc. in Calcite, in Archaean crystalline limestone, analogous to the Magnetic beds of Type 13. At Franklin Furnace and Sterling, towns about 8 miles apart in Northwestern N.J. is found an extended belt of crystalline limestone and in it those two unique beds. At Franklin the ore body in three quarters of a mile long and bends around in S shaped synoli-nal two of whose sides are folded together and that has afterwards been tilted. Trap dikes intersect it. The bed varies somewhat but consists essentially of crystals of franklinite (approximating 3 and 1000) thickly set in a matrix of zincite, willemite and calcite. In the same limestone magnetite layers have also been found. At Sterling there are two beds outcropping on a hillside with a depression in the country rock between them from which a great quantity of calamine was formerly extracted. (Views and Sections).

The ores are also an important source of manganese.

These deposits are entirely unique and a hard problem as regards origin. On the analogy of magnetite they may have been a kind of sedimentary bog ore bed which was later metamorphosed to the present minerals.

Blake.On the Zinc Mines of Franklin Sussex Co. N.J. A.J.S.I 2d ser.

Credner H. ON the Franklinite Beds B.& H.Zeit.1866 29, and 1871 369.
Geology of New Jersey. 1868(with a map) and subsequent annual Repts
Vanuxem & Keating On the Geol. & Mineralogy of Franklin Sussex Co.
N.J.. Phila. Acad. Sci. Vol. II p. 277.
Note. Blende is known in numerous places in the Rocky Mtns. and is often argentiferous but it is not as yet profitably smelted for zinc and is a drawback to the lead-silver processes.

ZINC PRODUCTION.

	1850	1870	1875	1880	1885	1887	1888
New Jersey		25000	13500	28300	38500	7440	
Virginia							
Illinois					19400	22270	
Missouri-Kansas					13100	20600	
England long tons	1000			22000	23000		26633
Belgium& Rhine Dist	14700	45700	49900	98800	129700	130990	133215
Germany(Silesia)	28600			644	79600	81378	83375
Other Countries				21500	23700	23100	23752
Total U.S.			15800	23200	40680	503340	55912
Total Foreign				206800	256200	254800	267005

The American estimate is in short tons, the others in long tons.
The production of the U.S. in 1889 is estimated at 59500.

Much of the N.J. ore is employed to make zinc-oxide for paint, hence the discrepancy in the totals, they being metallic zinc, for the manufacture of which but a small proportion of the N.J. ore is employed.

LEAD AND SILVER.

There are two general methods of extracting silver from its ores; the one, indirectly by smelting with and for lead; the other by amalgamation, chlorination or some such process. Hence under silver there are two classes of mines, lead-silver, being one; high grade silver ores the other. Both have almost always varying amounts of gold. The lead-silver mines furnish also as noted above by far the greater portion of the lead produced in the U.S.

Ores adapted to lead-silver metallurgical treatment form in general the oxidized alteration products of the upper parts, (above permanent water level) of deposits of galena and pyrites. They may be well marked fissure veins, chimneys, chambers , or contact deposits. Ores which of themselves are adapted to other processes are often worked in with the lead ores.
Utah Lead Silver. Map of Utah shown and geography & general geology outlined.

Type 29. Bingham and Big and Little Cottonwood Cañons Utah. Bedded veins often of great size, containing oxidized lead silver ores above, and galena and pyrites below the water level, in Carboniferous limestones, or underlying quartzite or on the contact

Chamber K. On the Tremblante Beds R.S.K.Keith.1888 32; and 1891 309.
Geology of New Jersey. 1868(with a map) and subsequent annual Reports
Vanuxem & Keating On the Geol. & Mineralogy of Franklin Sussex Co.
N.J., Philia. Acad. Sci. Vol. II p. 317.

Note. Blende is known in numerous places in the Rocky Mtns. and is often argentiferous but it is not as yet profitably smelted for zinc and is a drawback to the lead silver processes.

ZINC PRODUCTION.

	1850	1870	1875	1880	1885	1887	1888
New Jersey			28000	18800	28300	38000	7640
Virginia							
Illinois						19400	22270
Missouri-Kansas						13100	20800
England long tons		1000			22000	23000	26833
Belgium& Rhine Districts			45700	49900	98800	127700	130990
Germany(Silesia)		28800		644		79600	81278
Other Countries					24300	23700	23100
Total U.S.				18800	22200	40680	80234
Total Foreign				20880	25820	25	25

The American estimate is in short tons, the others in long tons.
The production of the U.S. in 1888 is estimated at 80000.

Much of the N.J. ore is employed to make zinc-oxide for paint, hence the discrepancy in the totals, they being metallic zinc, for the manufacture of which but a small proportion of the N.J. ore is employed.

LEAD AND SILVER.

There are two general methods of extracting silver from its ores; the one, indirectly by smelting with and for lead; the other by amalgamation, chlorination or some such process. Hence under silver there are two classes of mines, lead-silver, being ones high grade silver ores the other. Both have almost always varying amounts of gold. The lead-silver mines furnish also as noted above by far the greater portion of the lead produced in the U.S.,

Ores adapted to lead-silver metallurgical treatment form in general the oxidized alteration products of the upper parts, (above permanent water level) of deposits of galena and pyrites. They may be well marked fissure veins, chimneys, chambers, or contact deposits. Ores which of themselves are adapted to other processes are often worked in with the lead ores.

Utah Lead Silver. Map of Utah shown and geography & general geology outlined.

Type 35. Bingham, Alta and Little Cottonwood Canons Utah. Bedded veins often of great size, containing oxidized lead silver ores above, and galena and pyrites below the water level, in Carboniferous limestones, or underlying quartzite or on the contact

between the two. The mines are situated in the Oquirrh and Wasatch Mtns., south west and south east of Salt Lake City in canons well up towards the summits. The region is much disturbed and there are great faults and porphyry dikes and knobs of granite associated with the sedimentary rocks. The ores occur in belts extending considerable distancees and these in places have the rich chutes or chimneys of oxidized products. In Bingham Canon an immense bed of auriferous quartz is found overlying the lead zone and next the hanging. Some peculiarity about the gold prevents its esay treatment. Other fissure veins in the massive rock of the region are known but are of less importance. (Historical mention of their discovery and development; the Old Telegraph Group, the Emma, etc.)

Type 29a. Tooele Co. Bedded veins in limestone or between it and quartzite containing lead-silver ores with ochres, in rich chutes. The deposits occur on the west side of the Oquirrh range in Ophir and Dry Canon over the divide from Bingham. The principal mine is the Honorine. Fissure veins also occur in the region but are of less importance.

Blake W.P. Brief Description of the Emma Mine. A.J.S. III.2. 216.
E.& M.Jour. Little Cottonwood & Bingham, Utah Aug.14. 1880. p.106
Hollister.O.J. Gold and Silver Mining in Utah.M.E.16. 3. Rec.
Huntley.D.B. 10th. Census Vol. 13. p.407.
Lavagnino.G. The Old Telegraph Mine M.E. 16. 25.
Raymond.R.W. Min. Resources West of the Rocky Mtns. 1868-76. and
Brown J.R. do. 1867. 68.
Reports of the Director of the Mint. Annual.
Silliman B. Geol. and Mineral. Notes on some Mining Dist. of Utah
A.J.S. III, 3. 195.

Type 29b. Tintic Dist. Ore beds or belts, three in number, and one to three miles long, parallel with the stratification of vertical blue limestones, but sometimes running across them. The ore bearing zone is 300'-600' wide in at least one belt and bears in places rich chutes of carbonate ore. The Grisman Mammoth has been referred to under copper (Type 30h) as it contains much copper. The ore is thought by Hollister to have replaced limestone.

Huntley D. B. as above. Also Hollister O.J. as above.
Newberry J.S. E.& M. Jour. Sep. 13 & 20 1879.

Note. Mention should also be made of Lead-silver ores in Summit Co. at the Crescent and other mines.

Type 30. Hornsilver Mine Utah. A contact fissure between limestone and rhyolite containing at the Hornsilver Mine a "chimney" of lead-silver ores with considerable barite in the gangue. This contact fissure is known for two or three miles but has been proved of value alone at the above mine. Here the walls have pinched twice in going down making three ore bodies. Considerable arsenic and less antimony are found in the ore, and some ruby silver.

Hollister O.J. As above.
Hooker W.A. Report quoted in 10th Census Vol. 13. p. 464.

between the two. The veins are situated in the Quartz and Tuscan Mine, south west and south east of Salt Lake City in narrow well up towards the summits. The region is much disturbed and there are great faults and porphyry dikes and knobs of granite associated with the sedimentary rocks. The ores occur in belts containing considerable disseminated rock. The ores are chiefly chlorides and these in places have the rich sulphides of silver as a result of oxidized products. The Bingham Canon mine had of late years been yielding from the lead zone and most the bonanza. Some peculiarity about the gold prevents its easy treatment. Other flourspar veins in the massive rock of this region are known but are of less importance. (Mineralogical mention of their discovery and development; the Old Telegraph Dyke, the Mono, etc.)

Type 29a. Rocks Co. Bedded veins in limestone or between it and quartzite containing lead-silver ores with calcite, in rich cluster. The deposits occur on the west side of the Quartz range in Ophir and Dry Canon over the divide from Bingham. The principal mine is the Monarch. Minor veins also occur in the region but are of less importance.

Blake W.P. Brief Description of the Rocks Mine, A.J.M. XII.3, 218.
E.& M.Jour, Lately Contracted & Engineer, Sept Aug.16, 1890, p.108
Hollister.O.J. Gold and Silver Mining in Utah.M.R.16. 5. Geo.
Huntley.D.H. 10th, Census Vol. 13. p.607.
Lovering.G. The Old Telegraph Mine M.R. 14. 22.
Raymond.R.W. 4th. Reconnoissance Tour of the Rocky Mts. 1868'70. and
Brush J.E. do. 1867. 68.
Reports of the Director of the Mint. Annual.
Stillman B. Geol. and Mineral. Notes on some Mining Dists. of Utah
A.J.S. XII. 3. 198.

Type 29b. Tintic Dist. Ore bodies or veins, lodes in number, and one to three miles long, parallel with stratification of variegated blue limestones, but sometimes running across them. The ore bearing zone is 200'-600' wide in at least one belt and bears in places rich shoots of ore-bodies ore. The Uncle Sammuel has been referred to under copper (Type 29b) as it contains much copper. The ore is thought by Hollister to have replaced limestone.
Huntley D. Ref as above. Also Hollister O.J. as above.
Newberry J.S. E.& M. Jour. Sept. 18 & 25 1879.
Note. Mention should also be made of Beaconsfield ores in Summit Co. at the Dreadnaught and other mines.

Type 30. Horn-silver Mine Veins. A contact fissure between limestone and rhyolite containing at the Horn-silver Mine a "chimney" of lead-silver ores with considerable bunts in the gangue. This contact fissure is known for two or three miles but has been proved of value alone at the above mine. Here the veins have plunged twice in going down making three ore bodies. Considerable arsenic and lime minerals are found in the ore, and some rich silver.
Hollister O.J. As above.
Hooker W.A. Report quoted in 10th Census Vol. 13. p. 664.

Type 30a. Carbonate Mine Utah. Fissure vein in hornblende-andesite filled with pebbles from the walls, cemented by clay and galena, oxidized near the surface. The mine is but two and a half miles from the Hornsilver and has been cited by Newberry as an instance of two veins of different character in the same country rock. But the microscope shows that the walls of one are rhyolite of the other hornblende-andesite. (Cf Type 37a).

Literature as above.

Type 30b. The Cave Mine. Caves in limestone connected by small ore-channels and more or less filled with deposits of limonite and oxidized lead ore. (Compare Kimball J.P. On the Silver Mines of Santa Eulalia Chihuahua. A.J.S. II.49. 161

Literature as above.

Note .The larger portion of the Utah Mines are for lead-silver but two others of great importance remain to be mentioned under silver itself. See Type 41a. & Type 41b.

Nevada Lead Silver. Map shown and geography and geology [illegible] outlined.

Type 31. Eureka Nev.. Bodies of oxidized lead-silver ores in greatly faulted and fractured Cambrian limestone with great outbreaks of eruptive rock near. The ores occur along a zone which was crushed by the movement of the faulted rocks on each side. The limestone is filled with fissures along which the ore bearing solutions have come and replaced the limestone in large irregular bodies. Cavities occur between the ore and the roof which resemble caves. A considerable section of the Palaeozoic rocks is exposed at Eureka and very interesting comparative studies have been made with parallel series in the east(Geology explained at length).

J.S.Curtis considers the ores to have been probably derived at great depth from the neighboring quartz-porphyry(rhyolite) and that they have replaced the limestone as sulphides. Subsequent elevation above the water level caused their oxidation and shrinkage leaving cavities above them. J.S.Newberry has argued that they are cave deposits like the Cave Mine(Type 30b). (Historical mention of the great Eureka Richmond controversey).

Becker G.F. 10th Census Vol. XIII p. 32. Rec.
Blake W.P.The Ore Deposits of the Eureka Dist.E.Nev. M.E. 6. 554.
Curtis.J.S. Silver Lead Deposits of Eureka Nev. Monograph VII.USGS.
Hague ,A.Geol. of the Eureka Dist. Unpub. Monograph.U.S.G.S.
Abstract in 3rd Annual Report Director U.S.G.S.
Keyes W.S. Eureka Lode of Eureka Nev. M.E. 6. 344.
Newberry J.S. S. of M. Quarterly. March 1880.
Raymond R.W. The Eureka-Richmond Case M. E. 6. 371.

Type 32. Leadville Col...Bodies of oxidized lead-silver ores passing in depth into sulphides, deposited in much faulted Lower Carboniferous limestone in connection with dikes and sheets of

Type 32a. Carbonate Mine Veins. Fissure veins in hornblende-andesite filled with rubble from the walls, cemented by clay and galena, oxidized near the surface. The veins lie but two and a half miles from the Normalyer and has been mined by Newberry as an instance of two veins of different elevation in the same country rock. But the microscope shows that the walls of one are rhyolite of the other hornblende-andesite. (Cf Type 27a).

Literature as above.

Type 32b. The Cave Mine. Caves in limestone caused by small ore shoots and replacement ores or lens filled with deposits of limonite and oxidized lead ore. (Compare Kimball J.P. On the Silver Mines of Santa Eulalia Chihuahua. A.J.S. II.42. 181

Literature as above.

Note .The larger portion of the Utah Mines are for lead-silver but two others of great importance remain to be mentioned under silver itself. See Type 41a. & Type 41b.

Nevada lead Silver. Map shown and geography and geology outlined.

Type 32. Aurora Mex.. Bodies of oxidized lead-silver ores in greatly faulted and fractured Cambrian limestone with great outbreaks of eruptive rock near. The ores occur along a zone which was crushed by the movement of the faulted rocks on each side.

The limestone is filled with fissures along which the ore bearing solutions have come and replaced the limestone in large irregular bodies. Oxidized zone between the ore and the rock which resembles coarse. A considerable section of the Paleozoic rocks is exposed at Aurora and very interesting comparative studies have been made with parallel series in the east(Geology explained at length).

J.S.Curtis considers the ores to have been probably derived at great depth from the neighboring quartz-porphyry(rhyolite) and that they have replaced the limestone as sulphides. Subsequent elevation above the water level caused their oxidation and enrichment leaving cavities above them. J.B.Newberry has argued that they are same deposits like the Cave Mine(Type 32b). (Historical mention of the great Aurora Richmond controversy).

Bember G.P. 10th Census Vol. XIII p. 32. Nev.

Blake W.P.The Ore Deposits of the Eureka District,Nev. M.R. 6. 324.

Curtis.J.S. Silver Lead Deposits of Eureka Nev. Monography XI. 1884.

Emmons S.F. Geol. of the Eureka Dist. Unpub. Monograph.U.S.G.S.

Abstract in 3rd Annual Report Director U.S.G.S.

Keyes W.S. Eureka Lode of Eureka Nev. M.M. 6. 344.

Newberry J.S. S. of M. Quarterly. March 1880.

Raymond R.W. The Eureka-Richmond Case M. M. 6. 371.

Type 32. Leadville Col...Bodies of oxidized lead-silver ores passing in depth into sulphides, deposited in much faulted lower Carboniferous limestone in connection with dikes and sheets of

porphyry. Palaeozoic rocks are exposed at Leadville from a bottom quartzite through a series not too well determined, to undoubted blue Carboniferous limestones.(Geology of the Mosquito and Sawatch range explained). These have been extensively faulted and pierced by eruptive outbreaks making the geological structure very complicated. Along the contact between the porphyry and the blue limestone (or dolomite) the ores have replaced the limestone often in bodies of great size, making Leadville by far the largest source of these ores yet discovered. They do however run as much as a hundred feet into the limestone and also are found in the porphyry.

The principal mines occur on three hills, Fryer, Carbonate and Iron Hills. The ores are chiefly earthy carbonate of lead with chloride of silver in a clayey or silicious mass of hydrated oxides of iron and manganese. Some zinc also occurs and a long list of rarer minerals. All the mines produce small amounts of gold, which in one case (the Printer Boy) is of more importance than the silver. A few ore bodies are found at other horizons than the Lower Carboniferous. The ores are attributed by Emmons to a replacement of the limestone by sulphides when all were at a great depth (at least 10000 ft.) below the surface and before being elevated to their present position. The ore is thought to have been leached from the eruptive porphyries and deposited by descending solutions. A.A.Blow (l.c.) in a valuable paper argues against the descending currents and strongly for an ascent of mineral solutions from below.

(Historical account of the discoveries).

Ancluug F.M. The Geology of the Leadville Ore Dist. E.& M.J. April 10. 1880. p. 25. On the Origin of the Ore do. Dec.20 1879
Blow.A.A. The Geology and Ore Deposit of Iron Hill Leadville Col. M.E. June 1889.
" Annual Rept. Col. Sch. of Mines. 1887 pp. 62.
Emmons S.F. Geology and Mining Industry of Leadville Monograph 12 U.S.G.S.
" 2d Annual Rept .of Director of U.S.G.S. Rec.
" 10th Census Vol. XIII. p. 76.
E.& M.Jour. Origin of the Leadville Deposits. May 12 1888.p. 33.
" On the Evening Star Mine May 7. 81. p.361. Leadville
" Geology June 3&10 82. Historical May 30. Apr.6. 13. 20.
" 27. 1878. Also many other allusions 1879-80-81.
Freeland F.T. The Sulphides Dep. of S.Iron Hill. Leadville M.E.14.81.
Henrich C. The Character of the Leadville Ore Deposit. E.& M.J. Dec. 27. 1879. p. 470
Raymond R.W. Rept. on the Little Pittsburg Mine E.&.M.J. June 28.79
Ricketts L.D. The Ores of Leadville . Princeton. 1883.
Rolker C.M. Notes on Leadville Ore Deposits M.E. 14. 273. & 949.
Vinton F.L. Leadville & the Iron Mine.E.& M.J.Feb.15. 79. p. 110.

Type 32a. Aspen Col.. Bodies of lead-silver ores largely oxidized, occurring with much barite along the contact of the blue

porphyry. Limestone ranges are exposed at Leadville from a Lenten quartzite through a series not too well determined, to undoubted blue Carboniferous limestone.(Geology of the Mosquito and Sawatch ranges explained). These have been extensively faulted and pierced by eruptive outbreaks making the geological structure very complicated. Along the contact between the porphyry and the blue limestone (or dolomite) the ores have replaced the limestone often in bodies of great size, making Leadville by far the largest source of these ores yet discovered. They do however run as much as a hundred feet into the limestone and also are found in the porphyry.

The principal mines occur on three hills, Fryer, Carbonate and Iron Hills. The ores are chiefly carbonate of lead with sulphide of silver in a clayey or siliceous mass of hydrated oxide of iron and manganese. Some mine also secure and a long list of rarer minerals. All the mines produce small amounts of gold, which in one case (the Printer Boy) is of more importance than the silver. A few ore bodies are found at other horizons than the lower Carboniferous. The ores are attributed by Emmons to a replacement of the limestone by sulphides when all were at a great depth (at least 10000 ft.) below the surface and before being elevated to their present position. The ore is thought to have been leached from the eruptive porphyries and deposited by descending solutions. A.A.Blow (l.c.) in a valuable paper argues against the descending currents and strongly for an ascent of mineral solutions from below (Bleaviental account of the discoveries).

Authors P.M. The Geology of the Leadville Ore Dist., U.S.G.S. Mon. XX, 1890. p. 88. On the Origin of the Ore. Ore. Dep. XIV, 1896. A.A.Blow. The Geology and Ore Deposits of Iron Hill Leadville Col. M.E. June 1896.

Annual Rept. Bur. Sec. of Mines. 1897 pp. 88.

Mineral S.P. Geology and Mining Industry of Leadville Monograph 13 U.S.G.S.

" Annual Rept. of Director of U.S.G.S. Rec.

" 20th Census Vol. XIII. p. 70.

E.& M.Jour. Origin of the Leadville Deposits. May 15 1898.p. 32/.

" On the Evening Star Mine May 7. 81. p.361. Leadville

Geology June 1910 82. Historical May 30, Apr.6. 15. 80.

87. 1878, Also many other allusions 1879-80-81.

Broadland F.T. The Sulphides Dep. of S.Iron Hill. Leadville E.M.Je.M

Emerson G. The Character of the Leadville Ore Deposits. E.& M.J.

Dec. 27. 1879. p. 470

Raymond R.W. Repo. on the Ashley Pittsburg Mine E.&.M.J. June 28.79

Richards L.D. The Ores of Leadville . Princeton. 1888.

Walker C.K. Notes on Leadville Ore Deposits M.E. 14. 272. & 669.

Winston J.L. Leadville & the Iron Mine.Eng M.J.Feb.15. 79. p. 110.

Type 32a. Aspen Col.. Bedding of load-silver ores largely obscured, concurring with weak bands along the contacts of the blue

Lower Carboniferous limestone and a brown dolomitized lower lying portion of the same. Aspen is west of Leadville on the other side of the granitic continental divide and the ore occurs in the same belt of limestone separated only by the upheval of the Sawatch. The ore lies on the sides of a faulted synclinal fold. The rocks are much disturbed and associated with both granite and porphyry eruptions. The lower portion of the limestone strata appears to have been dolomitized to a rusty brown dolomite, while the upper is a very pure calcium carbonate. Along the contact between the two and more or less in cross fractures are found the ores. They are known over a stretch of several miles, north and south, but the principal ores are on both sides of the valley of the Roaring Fork near Aspen. Other deposits are known in the underlying quartzites. (Geological Sections, Views, and history).

Brunton D.W. Aspen Mtn. Its Ores and Mode of Occurrence. E.& M.J. July 14. & 21. 1888. pp.22 & 42.

Emmons S.F. Proc. of the Col. Sci. Soc.

Henrich C. Notes on the Geology and on some of the Mines of Aspen Mtn. M.E. 17. 156.

Lakes A. Geol. of the Aspen Mining Region. Ann. Rept. Col. Sch. Mines. 1886.

Newberry W.C. Notes on the Geol. of the Aspen Mining Dist. M.E. June 1889. Rec.

Silver L.D. The Geology of the Aspen Col. Ore Deposits. E.& M. J. March 17 & 24. 1888.

Type 32b. Ten Mile Col. Bodies of argentiferous galena, pyrite and blende, in thin beds of Upper Carboniferous limestone on their contact with overlying micaceous sandstones or with sheets and dikes of porphyry. Ten Mile is north of Leadville and at a higher altitude and in a region enormously disturbed and pierced even more than Leadville by sheets and dikes of porphyry. The ores are far less oxidized than at Leadville and also more rebellious. The Robinson is the principal mine.

Type 32c. The Eagle River Mines near Red Cliff Eagle Co. may be mentioned here. They contain galena and its alteration products in Carboniferous limestone on the contact between it and quartzite or porphyry. Lying lower than the lead silver deposits and in Cambrian quartzite on the contact with an overlying sandstone are found chutes carrying gold in talcose clay. The Monarch Mine in Chaffee Co. south of Lradville deserves mention in this connection producing lead silver ores from limestone. Small deposits of lead silver ores have also been worked in the San Juan district in connection with the high grade silver ores (See Type 36).

Emmons S.F. Tenth Census Vol. XIII p. 73. Also forthcoming Monograph of U.S. Geological Survey.

Olcott E.E. Battle Mtn. Mining District. Eagle Co. Col. E & M. Journal June 11. 1887. pp. 417 & 436.

Lower Carboniferous limestone and a brown bleached layer lying
portion of the same. Aspen is west of Leadville on the other side
of the granitic sentimental divide and the ore occurs in the same
belt of limestone separated only by the upthrust of the Sawatch.
The ore lies on the sides of a faulted synclinal fold. The rocks
are much disturbed and associated with both granite and porphyry
eruptions. The lower portion of the limestone strata appears to
have been dolomitized to a rusty brown dolomite, while the upper
is a very pure calcium carbonate. Along the contact between the
two and more or less in cross fractures are found the ores. They
are known over a stretch of several miles, north and south, but
the principal ores are on both sides of the valley of the Roaring
Fork near Aspen. Other deposits are known in the underlying quartz
rites. (Geological Sections, Views, and History).
Emmons S.F. Prvg. of the Col. Sci. Soc.
Hamrick C. Notes on the Geology and on some of the Mines of Aspen
Min. M.E. IV. 1886.
Lakes A. Geol. of the Aspen Mining Region. Ann. Rept. Col. Bur.
Mines. 1886.
Newberry W.C. Notes on the Geol. of the Aspen Mining Dist. M.E.
June 1889, Rec.
Silver L.D. The Geology of the Aspen Col. Ore Deposits. E.& M.J.
March 17 & 24. 1888.

Type 32b. Ten Mile Col. Bodies of argentiferous galena, pyrite
and blende, in thin beds of Upper Carboniferous limestone on thrust
contact with overlying micaceous sandstones or with sheets and
dikes of porphyry. Ten Mile is north of Leadville and at a higher
altitude and in a region enormously disturbed and pierced even more
than Leadville by sheets and dikes of porphyry. The ores are far
less oxidized than at Leadville and also more replaced. The
Robinson is the principal mine.

Type 32a. The Eagle River Mines comp. and Gilt Edge Co. may be
mentioned here. They contain galena and its alteration products
in Carboniferous limestone on the contact between it and quartzite
or porphyry. Lying lower than the lead silver deposits and in
Cambrian quartzite on the contact with an overlying sandstone are
found shutes carrying gold in tabose clay. The Mountain Mine in
Gilt Edge Co. south of Leadville deserves mention in this connection
producing lead silver ores from limestone. Small deposits of lead
silver ores have also been worked in the San Juan District in con-
nection with the high grade silver ores (See Type 36).
Emmons S.F. Tenth Census Vol. XIII p. 78. Also Forthcoming Mono-
graph of U.S. Geological Survey.
Olcott E.E. Battle Mtn. Mining District. Eagle Co. Col. E & M.
Journal June 11. 1887. pp. 417 & 430.

Type 32c. Kelley Lode. N.M. A deposit of oxidized lead ores with some blende, galena etc. along the contact between slates and porphyry. The ore body is in the Magdalena Mtns. 30 miles west of Socorro and has supplied the smelter located there. The ore is low in silver. In the Lake valley further south in Doña Ana County are found other deposits of oxidized lead ores along the bedding planes of limestones apparently of Subcarboniferous age. Similar ores are found on the west side of the Miembres Mtns. in Grant Co..
Report of the Director of the Mint. 1882 p. 376.
Silliman B. The Mineral Regions of N.M. M.E. 10. 424.
Lanman. W.N.Y. Ores Deb. of N.M. S of M. Quarterly. VI. 135.

Type 33. Wickes, Montana. Veins carrying galena, blende, and copper and iron pyrites in a quartz gangue on the contact between granite and eruptions of liparite which penetrate it. The district is near Helena and the ore is made available by the introduction of concentration. Other deposits near Glendale in the southern part of the state produce a large quantity of base bullion. The Heela Mines are a series of ore bodies containing "galena zinc-blende, copper and iron pyrites, and their oxidation products" at different horizons on the stratification planes of a blue gray limestone.
Emmons S.F. 10th Census Vol. XIII. p. 97.
Kemp R.H. The Gregory Lode. E.& M.J. May 8. 1880. p. 316.
Lindgren W. Min. Resources U.S. 1883-84. p. 422.

Type 33a. Black Hills S. Dak. Although geographically removed from the above the lead silver deposits of the Black Hills are mentioned here. Deposits of galena in Carboniferous limestones associated with porphyry dikes and sheets are known in the northern portion of the Hills near Carbonate and Galena. Various attempts never very successful have been made to smelt them.
Carpenter F.B. Prelim. Rep. on the Geol. etc. of the Black Hills Dak. Sch. of Mines. Rapid City 1888. p.124.
" Ore Dep. of the Black Hills. M.E. 17. 570.
Emmons S.F. 10th Census Vol. XIII p.91.

Type 34. Wood River Idaho. Bodies of argentiferous galena and its oxidized products irregularly distributed in limestone. The country is formed by limestones slates and granite and bears other silver ores of different character. A lead smelting plant has been recently established at Ketchum.
Becker G.F. 10th Census Vol. XIII p.55.
E.& M. Journal July 2nd 1887. P. 2.
Rept. of the Director of the Mint. (Burchard) 1882. p. 198.

Type 34a. Coeur d'Alene Idaho. Galena and its oxidized products in a mineralized zone having a well marked quartzite footwall and a brecciated impregnated hanging; the ore being in large chutes and filling smaller fissures in the fractured roof. The mines are in Milo Creek Canon in the Bitter Root Mountains, northern Idaho.

Type 88a, Butler Lode, Mont. A deposit of oxidized lead ores with some bismuth, selenides, along the contact between slates and porphyry. The ore body is in the Mesozoic Horn, 30 miles east of Bozeman and has supplied the smelter located there. The ore is low in silver. In the Lake valley district ocurs in Doña Ana County are found other deposits of oxidized lead ores along the bedding planes of limestones apparently of Pennsylvanian age. Similar ores are found on the west side of the Mimbres Mtns. in Grant Co..

Report of the Director of the Mint. 1882 p. 378.
Billings E. The Mineral Regions of N.M. N.M. 1b. 1884.

Type 88. Wiskon, Montana. Veins carrying galena, blende, and copper and iron pyrites in a quartz gangue on the contact between granite and eruptions of liparite which penetrate it. The district is near Helena and the ore is much oxidized by the intrusions of nonmetallics. Other deposits near Glendale in the southern part of the state produced large quantity of base bullion.
The Neola Mines are a series of ore bodies containing "galena blende, copper and iron pyrites, and their oxidation products" in different horizons in the crystalline plates of a blue gray limestone.
Emmons S.F. 10th Census Vol. XXII. p. 97.
Kemp J.F. The Geology Neola. N.Y.A.M.J. May 5. 1900. p. 538.
Lindgren W. Min. Resources W.S. 1898-99. p. 888.

Type 88a. Black Hills S. Dak. Although geographically removed from the above the lead silver deposits of the Black Hills are mentioned here. Deposits of galena in Carboniferous limestones associated with porphyry dikes and sheets are known in the southern portion of the Hills near Carbonate and Galena. Various attempts never very successful have been made to smelt them.
Carpenter L.G. Trans. Am. Inst. Min. Eng. XX. 879.
Min. Res. of Mines. Rpt'd Gilp 1882. p.126.
Ore Dep. of the Black Hills. N.Y. 870.
Emmons S.F. 10th Census Vol. XXII p.91.

Type 89. West River Idaho. Bodies of argentiferous galena and its oxidized products irregularly distributed in limestone. The country is formed by limestone slates and granite and bears other silver ores of different character. A lead smelting plant has been recently established at Potsdam.
Becker G.F. 10th Census Vol. XXII p.85.
M.& M. Journal July 2nd 1887, p. 8.
Rept. of the Director of the Mint. (Appendix) 1882, p. 198.

Type 86a. Cerro d'Alpre Idaho. Galena and its oxidized products in a limestone some having a well marked quartzite footwall and a brecciated impregnated hanging the ore being in large shoots and filling cavities in the fractured roof. The mines are in Nilo Creek Canon 12 the Salmon River Mountains, northern Idaho.

The rocks are quartzite and thin beds of schist much folded along east and west axes. In this way they became faulted and shattered and in the principal mineralized belt afford an opportunity for the deposit of the lead ores. The mines are very important and supply large new smelters in Mont. and on the Pacific coast.

Clayton J.E. The Coeur d'Alene Silver-Lead Mines. E.& M.J. Feb 11 1888 p. 108.

Note. Other smaller lead silver districts are known in Arizona and Cal. and elsewhere in the States referred to above, but they are not commensurate with those mentioned.

SILVER SERIES- GOLD.

The two "precious" metals are so generally associated together that they cannot be separately treated. While endeavoring to preserve the distinctive impression given by types it is practicably impossible to embrace all the widely varying phenomena of the silver-gold veins of the west in any other than an approximate way. Hence geographical considerations are placed first and where markedly similar ore bodies in different States are grouped together, cross references are given.

SILVER MINERALS.

		Ag	S	As	Sb	Cl
Native Silver		100				
Argentite (Silver Glance)	Ag_2S	87.1	12.9			
Proustite (light ruby Silver)	$3Ag_2S, As_2S_3$	65.5	19.4	15.1		
Pyrargerite (dark " ")	$3Ag_2S, Sb_2S_3$	59.8	17.7		22.5	
Stephanite (Brittle Silver)	$5Ag_2S, Sb_2S_5$	68.5	16.2		15.3	
Cerargerite (Hornsilver)	AgCl	75.3				24.7

Also with galena (Cf. Lead), with Tetrahedrite, (Cf. Copper). Gold occurs combined with tellurium in a few rare tellurides; mechanically mingled with pyrites, and as the uncombined native metal. The ores of the precious metals are divided into two classes from a metallurgical point of view. 1st. those whose amount of precious metal amalgamates readily with mercury and is thus obtained with comparative ease. The Free Milling Ores.

2nd. those which require roasting, or some previous treatment before amalgamation, chlorination or similar treatment or must be smelted primarily for lead or copper from which the precious metal is afterward extracted, the Rebellious Ores.

Annual Reports of the Director of the U.S. Mint. Rec.

Blake W.P. The Various Forms in which Gold occurs in Nature. Rept. of the Dir. Mint. 1884. p. 573. Rec.

Brown, Raymond and others. 1868 to 1876. Annual.

Lock A.G. Gold. 1882.

Mineral Resources West of the Rocky Mountains.

Mineral Resources of the U.S. Publication of the Geol Survey.

Phillips J.A. Ore Deposits. 1884. The Mining and Metallurgy of Gold and Silver 1867.

10th Census Report on the Precious Metals.

The rocks are quartzite and thin beds of schist much folded along east and west axes. In this way they become faulted and shattered and in the principal mineralized belt afford an opportunity for the deposit of the lead ores. The mines are very important and supply large smelters in Mont. and on the Pacific coast.

Clepton A.M. The Ozarr d'Alene Silver-lead Mines.E.& M.J.Feb 11 1888 p. 108.

Note. Other smaller lead silver districts are known in Arizona and Cal. and elsewhere in the States referred to above, but they are not commensurate with those mentioned.

SILVER BEARING- GOLD.

The two "precious" metals are so generally associated together that they cannot be separately treated. While endeavoring to preserve the distinctive impression given by types it is practically impossible to embrace all the widely varying phenomena of the silver-gold veins of the west in any other than an approximate way. Hence geographical considerations are placed first and where markedly similar ore bodies in different States are grouped together, cross references are given.

SILVER MINERALS.

	Ag	S	As	Sb	Cl
Native Silver	100				
Argentite (Silver Glance) Ag_2S	87.1	12.9			
Proustite (Light ruby Silver) $3Ag_2S\ As_2S_3$	65.5	19.4	15.1		
Pyrargyrite (dark " " ") $3Ag_2S\ Sb_2S_3$	59.8	17.7		22.5	
Stephanite (Brittle Silver) $5Ag_2S\ Sb_2S_3$	68.5	16.3		15.3	
Cerargyrite (Horn Silver) AgCl	75.3				24

Also with galena (Gl. lead), with Tetrahedrite, (Cf. Copper). Gold occurs combined with tellurium in a few rare tellurides; mechanically mingled with pyrites, and as the uncombined native metal. The ores of the precious metals are divided into two classes from a metallurgical point of view. 1st. those whose amount of precious metal amalgamates readily with mercury and is thus obtained with comparative ease. The Free Milling Ores.

2nd. those which require roasting, or some previous treatment before amalgamation, chlorination or similar treatment or must be smelted primarily for lead or copper from which the precious metals is afterward extracted, the Refractions Ores.

Annual Report of the Director of the U.S. Mint. Rec.

Blake W.P. The Various Forms in which Gold occurs in Nature. Rep of the Dir. Mint. 1886. p. 575. Rec.

Brown, Raymond and others. 1888 to 1876. Annual.

Lock A.C. Gold. 1888.

Mineral Resources of the Rocky Mountains.

Mineral Resources of the U.S. Publication of the Geol Survey.

Phillips J.A. Ore Deposits. 1884. The Mining and Metallurgy of Gold and Silver 1867.

10th Census Report on the Precious Metals.

Type 22a. Atlantic Border. Already mentioned. (p35). Only of historical interest although lately some attention has been directed to Sullivan Me. The veins have pyrite and probably stephanite in a quartz gangue in slates associated with granite knobs and trap dikes of later age than the veins. Some silver is generally found in the galena of the eastern States.

Kempton C.W. Sketches of the New Mining Dist. at Sullivan Me. M.E. 7. 349.

Wadsworth M.E. Theories of Ore Deposit Proc. Boston Soc. N.H. 1884 p.205. E.& M.J. May 17. 84. Bull. Mus. Comp. 3Vol. VII. 181

Type 35. Silver Islet. Lake Superior. A vein carrying native silver, argentite tetrahedrite, galena, blende and some nickel and cobalt compounds in a gangue of calcite, in flags and shales of the Animikie or Huronian Systems, and cutting an immense diorite dike, within which alone is the vein productive. Although just over the national boundary the Silver Islet vein is mentioned as it was owned in the U.S.. The north shore of Lake Superior contains numerous argentiferous veins althouhg none have proved as productive as this one. It is a striking illustration of the influence of the wall rock on the contents of the vein. The Islet was only a rock less than 90' square and the difficulties of mining were very great. Over $3.000.000. in Silver were taken out.

Bell R. E.& M. Jour. Jan 8 & 15, 1887. The Silver Mines of Thunder Bay L.S. See also May 14, 1887.

Courtis W.M. On Silver Islet. E.& M. Jour. Dec. 21. 78. and M.E. 5. 474.

Geology of Canada. 1863. 717.

Lowe F.A. The Silver Islet Mine and its Present Development E.& M. Journal Dec. 16th. 1882 p.321.

Mac Farlane T. Silver Islet. M.E. 8. 226

" " Canadian Naturalist Vol. IV. p. 37.

McDermott E.& M. J. Vol. 23. No's 4 & 5.

The Region of the Rocky Mtns. and the Black Hills (VIII)

Type 36. New Mexico. Geology of the tertiary explained at length. The chain of the Rocky Mtns. trends across it from south to north. In the southwestern corner of the teritory is

Type 36a. Grant Co. whose lead silver deposits have already been referred to. (Type 32c). North of Silver City are quartz veins with gold and silver in diabase and quartz-porphyry; and again west of Silver City are ferruginous deposits with chlorides and sulphides of silver in limestone. In the Burro Mtns. are the silver ores in limestones apparently of the Lower Silurian System. The Santa Rita Mountains contain as well as copper (See Type 20d) silver and gold in quartz veins in eruptive rocks.

The mines of Doña Aña County have been referred to (Type 32c). In Lincoln Co. Gold Ores are reported from the White Oak Dist. The principal mines of Socorro Co. have been mentioned (Type 32c)

Type 32a. Alamosa Border, already mentioned. (p.3). Only of historical interest although lately some attention has been directed to Sullivan Mo. The veins have pyrite and probably sphalerite in a quartz gangue in slates associated with pyramids knobs and strings of later age than the veins. Some silver is generally found in the galena of the eastern districts.

Hampton C.W., Sketches of the Mex Mining Dist.: St Sullivan Mo.,M.J.M. v. 8:9.

Wadsworth M.E. Theories of Ore Deposits Proc. Boston Soc. N.H. 1884 p.303. U.S.G.S. 3rd Ann. Rep. p.47. Bull. Mus. Comp. Zool. VII.183

Type 33. Silver Islet, Lake Superior. A vein carrying native silver, argentite tetrahedrite, galena, blende and some nickel and cobalt compounds in a gangue of calcite, in flags and shales of the Animikie or Huronian Systems, and cutting an immense diorite dike, within which alone is the vein productive. Although just above the national boundary the Silver Islet vein is mentioned as it was owned in the U.S. The north shore of Lake Superior contains numerous argentiferous veins although none have proved as productive as this one. It is a striking illustration of the influence of the wall rock on the contents of the vein. The islet was only a rock less than 50' square and the difficulties of mining were very great. Over $5,000,000. in silver were taken out.

Bell R. R.& M.Jour. Jan 6 & 13, 1887. The Silver Mines of Thunder Bay L.S. See also May 14, 1887.

Currie W.H. On Silver Islet.R.& M.Jour.Dec.11.'75.and M.J.S.676.

Geology of Canada, 1863. 717.

Lowe T.A. The Silver Islet Mine and its Present Development R.& M. Journal Dec. 10th, 1887 p.381.

Mine Features Silver Islet.M.J. 5, 249

" " Canadian Naturalist Vol. IV, p. 97.

Molyneux R.& M. J. Vol. 33. No's & & &.

The Region of the Rocky Mts. and the Sierra Nevada(VIII)

Type 34. New Mexico. Geology of the vicinity explained at length. The chain of the Rocky Mtns. travels across it from south to north. In the southwestern corner of the territory is

Type 34a. Organ Co. where lode silver deposits have already been referred to.(Type 32a). North of Silver City are quartz veins with gold and silver in diabase and quartz-porphyry; and again west of Silver City are ferruginous deposits with chlorides and sulphides of silver in limestone. In the Burro Mtns. are the silver ores in limestone apparently of the lower Silurian System. The Santa Rita Mountains contain as well as copper (See Type 30d) silver and gold in quartz veins in eruptive rocks.

The mines of Dona Ana County have been referred to (Type 32a). In Lincoln Co. Gold Ores are reported from the White Oak Dist. The principal mines of Socorro Co. have been mentioned (Type 32a)

and the copper in Permian sandstone under Type 21c. There are other silver bearing lodes in the Socorro Mtns. near the town of the same name. Henrich has described (l.c.) a curious deposit of quartz carrying gold and silver (the Slayback lode) on the contact between older bedded eruptions and a later siliceous dike in the Mogollon Range. In Santa Fe Co. are the important placer mines (See Type 47) and thin veins of galena in rhyolite. In Bernalillo Co. are other placers on the slopes of the Sandia Mtns. In Colfax Co. in the Rocky Mtns. are other placers and reported gold and silver mines. These notes are mostly taken from [illegible] Vol. XIII of the 10th Census.

Blake W.P. Gold in New Mex. Proc. Bost.Soc. Nat.Hist.VII.July'59.p16.
" " Observations on the Geol. etc. near Santa Fe A.A.A.S.1859.
Henrich C. The Slayback Lode N.M. E.& M.J. July 13. 1839. p.27.
Owen R.E.& Cox E.T. Rept. on the Mines of N.M. Wash. 1885.
Report of the Director of the Mint. 1882. p. 339.
Silliman B. Mineral Resources of Southern N.M. M.E. 10.424. E & M. Jour. Oct.14 & 21 1882. pp.199 & 212.

Type 37. Colorado. Geology of the State explained at length. Prairies on the east, mountains and parks in the middle, plateau on the west. San Juan Region. Portions of several counties in the south western part of the state. The chain of the San Juan Mtns. consists of great successive outflows of eruptive rocks, porphyry, diabase, diorite, basalt etc. which cover up the Archaean and later sedimentary terranes except in a few scattered exposures. Considerable masses of rocks formed of fragmental ejectamenta are also known. All these are crossed by immense vertical veins largely with quartz gangue, and containing argentiferous minerals of the usual species, galena, tetrahedrite, pyrargerite and native silver as well as bismouth compounds. Gold has been quite subordinate, although some late developments near Ouray have shown some peculiar and interesting deposits. R.C.Hills in the Proc. Col. Sci. Soc. 1888 traced three systems of veins. 1st. Silver bearing, narrow(6" to 3') nearly vertical veins with base metal ores and no selvage. 2nd Large, strong gold bearing veins, dipping 60° with selvages and intersecting (1). 3rd Like 2, but larger and more persistent and occasionally carrying bismuth and antimonial ores and gold with little or no silver. T.B.Comstock (M.E. 15. 218) has classified the veins in three radiating systems. 1st.the northwest with tetrahedrite (freibergite). 2nd. the east and west with bismuth and less often nickel and molybdenum. 3rd. the north east with tellurides, with antimony and sulphur compounds of the precious metals. Quite recently a series of small caves in quartzite overlaid by bituminious shales near Ouray have been found to contain native gold and have excited great interest. They are thought by Endlich to be in the place of shale inclusions now dissolved away, and that then the gold was precipitated on the walls. Placer Gold

and the copper in Permian sandstone under Type 81a. There are other silver bearing lodes in the Socorro Mts. near the town of the same name. Herrick has described (1.c.) a curious deposit of quartz carrying gold and silver (the Blaybock lode) on the contact between older bedded eruptions and a later alkaline dike in the Magdalena Range. In Santa Fe Co. are the important placer mines (See Type 47) and thin veins of galena in rhyolite. In Bernalillo Co. are other placers on the slopes of the Sandia Mts. In Colfax Co. in the Rocky Mts. are other placers and reported gold and silver mines. These notes are mostly taken from [illegible] Vol. XXIX of the JOUR. Geology.

Blake W.P. Gold in New Mex. Proc. Boet.Soc. Nat.Hist.VII.July'59.pp.

" Observations on the Geol. ets. near Santa Fe A.A.A.S.1859.

Herrick C. The Blaybock Lode N.M. E.& M.J. July 18. 1885. p.27.

Owen R.B.& Cox E.T. Repts. on the Mines of N.M. Wash. 1885.

Report of the Director of the Mint. 1882. p. 339.

Williams S. Mineral Resources of Southern N.M. N.Z. 10.494. E & M. Jour. Oct.16 & 23 1886. pp.299 & 312.

Type 87. Colorado. Geology of the States explained at length. Prairies on the east, mountains and parks in the middle, plateaus on the west. San Juan Region. Portions of several counties in the south western part of the state. The chain of the San Juan Mts. consists of great successive outflows of eruptive rocks, porphyry, diabase, diorite, basalt ets. which cover up the Archaean and later sedimentary terranes except in a few scattered exposures. Considerable masses of rocks formed of fragmental ejectamenta are also known. All these are crossed by immense vertical veins largely with quartz gangue, and containing argentiferous minerals of the usual species, galena, tetrahedrite, pyrargyrite and native silver as well as bismouth compounds. Gold has been quite evidently, although some late developments near Ouray have shown some peculiar and interesting deposits. R.G.Hills in the Proc. Col. Sci. Soc. 1886 treated three systems of veins. 1st. Silver bearing, narrow(6" to 3') nearly vertical veins with base metal ores and no selvage. 2nd large, strong gold bearing veins, dipping 60° with selvages and interesting (1). 3rd like B, but larger and more persistent and occasionally carrying bismuth and antimonial ores and gold with little or no silver. T.B.Comstock (M.K. 15. 318) has classified the veins in three radiating systems. 1st.the northwest with tetrahedrite (freiberyite). 2nd. the east and west with bismuth and lead often nickel and molybdenum. 3rd. the north east with tellurides, with antimony and sulphur compounds of the precious metals. Quite recently a series of small caves in quartzite overlaid by limestones adjacent Ouray have been found to contain native gold and have excited great interest. They are thought by Hewlett to be in the place of shale inclusions now dissolved away, and that when the gold was precipitated on the walls. Placer Gold

Mines (Type 47) are quite extensively worked in San Miguel Co. Silverton and Ouray are the principal towns of the San Juan.

Comstock T.B. The Geology and Vein Structure of S.W.Col. M.E. 15. 218. Also 11. 165. and E & M.J. numerous papers running through 1885.

" " Hot Spring Formation in the Red Mtns. Dist. Col. etc. M.E. 17. 261

Emmons S.F. On the San Juan Dist E.& M.Jour June 9. 1883. p.332.

" " Structural Relations of Ore Deposits M.E. 16. 804.

" " 10th Census. Vol. 13. p.60. Rec.

Endlich F.M. The Origin of the Gold Dep. near Ouray Col. E.& M.Jour Oct. 19. 1889.

E.& M.Jour. The San Juan Region. Col. Aug. 27 81. p.136. Also Sept. 24. '81. p.201. July 17. '80. Dec. 20. '79. and many other references about 1879. 1880 etc.

Hills R.C. Proc. Col. Sci. Soc. '83, On the San Juan Dist.

Ihlseng M.C. Review of the Mining Interests of the San Juan Region. Rep. Col. State Sch. of Mines 1885. P. 27.

Kedzie G.E. The Bedded Ore Deposit of Red Mtn. Mining District. Ouray Co. Col. M.E. 16. 570.

Koenig G.A. & Stockder.M.Lustrous Coal and Native Silver in a Vein in Porphyry Ouray Co. Col. M.E.9. 650.

Schwarz T.E. The Ore Dep. of Red Mtn. Ouray Co. Col. M.E. 1889.

Van Diest P.H. On San Juan Dist. Proc. Col. Sci. Soc. Jan. 1886.

The Gunnison Region. This lies on the western slope of the continental divide and embraces both mountains and plateau. West of the main and older range are the later Elk M't'ns in which several mining districts are located. Aspen has already been mentioned and the long series of ore bodies in the Carboniferous limestones. The other principal districts are Independence, Ruby, Gothic, Pitkin and Tin Cup. The ores at Independence are sulphides with silver in the Archaean. In the Tin Cup district the Gold Cup mine is in a black limestone and contains argentiferous cerussite and copper oxide. In the Ruby district the ores are in the Cretaceous rocks, and in the Forest Queen are ruby silver and arsenopyrite partly replacing a porphyry dike. On Copper Creek near Gothic a series of nearly vertical fissures traverse eruptive diorite rocks. They contain sulphide of silver and native silver. The Sylvanite is one of the principla mines. (These notes are taken from Emmons and Lakes as cited below). Summing up we have. Type 37b Gunnison Region (1) Veins carryinghigh grade silver ores in Archaean granite. (2) Veins carrying argentiferous lead carbonate in limestone. (3) High grade silver ores replacing porphyry dikes in Cretaceous sandstones. (4) Most important of all more or less oxidized argentiferous lead ores in Lower Carboniferous limestone (Type 32a).

Amelung F. Sheep Mtn. Mines Gunnison Co. E.& M.J. Aug. 28 1886. p.149.

Chadwick F.M. The Tin Cup Mines. Gunnison Col. E & M.Jour. Jan. 1. 1881 p. 4. See also (Type3e) for Iron Mines. (Type 32a) for lead silver.

Mines (Type 47) are quite extensively worked in San Miguel Co.
Silverton and Ouray are the principal towns. W. Cross, Telluride
Quadrangle U.S. Geol. Survey. Also Geology and Vein Structure of S.W.Col. M.M. 15.
216. Also 11. 168, and M & M.J. numerous papers running
through 1885.

Hot Spring Formation in the Red Mtn. Dist. Col. Sci. Soc. M.M. 17.
Lemons S.P. On the San Juan Dist. E.& M.Jour June 9. 1883. p. 372.
Structural Relations of Ore Deposits M.M. 16. 804.
" " 10th Census, Vol. 15. p. 60. Rep.
Endlich F.M. The Origin of the Gold Dep. near Ouray Col. M.& M. Jour
" " " Oct. 19. 1889.
M.& M. Jour. The San Juan Region. Col. Aug. 27 81. p. 156. Also Sept.
24. '81. p. 201. July 17. '80. Dec. 20. '79. and many other
references about 1879, 1880 etc.
Hills R.C. Proc. Col. Sci. Soc. '83. On the San Juan Dist.
Ihlseng M.C. Review of the Mining Interests of the San Juan Region.
Rep. Col. State Bur. of Mines 1883. P. 27.
Kemble G.E. The Added Ore Deposit of Red Mtn. Mining District.
Ouray Co. Col. M.M. 18. 870.
Koenig G.A. & Stoeckter, M. Immerous Coal and Native Silver in a Vein
in Porphyry Ouray Co. Col. M.M.9. 880.
Behrens T.E. The Ore Dep. of Red Mtn. Ouray Co. Col. M.E. 1883.
Van Diest P.M. On San Juan Dist. Proc. Col. Sci. Soc. Jan. 1888.

The Sunnison Region. Vein lies on the western slope of the
continental divide and traverses both mountains and plateaus.
Most of the main and older camps are the later Silt Mts in which
several mining districts are located. Aspen has already been mi-
ticned and the long series of ore bodies in the Carboniferous lime-
stones. The other principal districts are Independence. Ruby.
Gothic, Pitkin and Tin Cup. The ores at Independence are sulphides
with silver in the Archaean. In the Tin Cup district the Gold Cup
mine is in a black limestone and contains argentiferous galenite
and copper oxide. In the Ruby district the ores are in the Crest-
ecum rocks, and in the Forest Queen are ruby silver and arsenopy-
rite partly replacing a porphyry dike. On Copper Creek near Gothic
a series of nearly vertical fissures traverse sericitic diorite
rocks. They contain sulphids of silver and native silver. The
Galena is one of the principle mines. (These notes are taken
from Emmons and Lakes as cited below). Summing up we have. Type 2Ma
Sunnison Region (1) veins carrying high grade silver ores in Archae-
an granite. (2) Veins carrying argentiferous lead carbonate in
limestone. (3) High grade silver ores replacing porphyry dikes in
Cretaceous sandstones. (4) Most important of all more or less
oxidized argentiferous lead ores in Lower Carboniferous limestone
(Type 22a). Ansheutz P. Sheep Mtn. Mines Sunnison Co. E.& M.J. Aug.
23 1884. p. 120.
Chesterman P.M. The Tin Cup Mines. Sunnison Col. E & M.Jour. Jan. 3.
1891 p. 6. See also (Types) for Iron Mines (Type 32a) for
lead silver.

Eagle Co. The lead silver mines at Red Cliff have already been mentioned (Type 32b) and also the underlying gold deposits. The Homestake mine north west of Leadville over toward Red Cliff is a vein of galena in granite and one of the first openings made in the region.

Mining Industry Denver. Jan. 10. 1890 p. 28 Battle Mtn. Quartzite Mines.
Olcott E.E. Battle Mtn. Mining Dist. Eagle Co. Col. E. & M. Jour. June 11 & 18 1887. p. 417 436.
Tilden G.C. Mining Notes from Eagle Co. Col. State Sch. of Mines Ann. Rep. 1886. p. 129.

Summit Co. The Ten Mile District which is the principal one has been mentioned under Type 32b. The Pride of the West Mine on Jacque Mtn. is peculiar being on a quartz porphyry dike which is partly replaced by ferruginous quartz and barite. Lake Co. containing Leadville has been treated under Type 32. Mention should also be made ofthe placer deposits in California Gulch which first attracted prospectors (1860) to the region. (Type 47).

Type 37c. Park Co. lying east of Lake and embracing the South Park has some mines on the eastern slopes of the Mosquito Range and in the Colorado Range in its north eastern corner. The latter are similar to the Georgetown silver ores mentioned under Clear Cr. Co. but the former are bodies of argentiferous galena and its alteration products in limestone and quartzite. Pyrite is also abundant and at times a gangue of barite appears. The mines are in the sedimentary series resting on the granite of the Mosquito Range and piereed by the porphyry outbreaks as at Leadville.

The Placer Deposits at Fairplay deserve mention as it was from these thatthe prospectors spread over the divide to the site of Leadville in 1860 (See also Type 47).

Jernegan J.L. The Whale Lode of Park Co. Col. M.E. 3. 352.

Chaffee Co. on the south contains the iron mines referred to under Type 13e. There are other gold veins near Granite and Buena Vista. The lead silver deposits of the Monaph district are mentioned under Type 32b. In Huerfano Co. in the Spanish Peaks, veins of galena, gray copper etc. are known and worked to some extent.

Type 37d. Rio Grande Co. In the Summit Dist. are a number of rich gold mines of which the Little Annie is the best known. They gold occurs in the native form, in quartz on the contact between a rhyolite and a trachyte breccia or andesite. The deposits are thought by R.C. Hills to be due to a silicification of the rhyolite along these lines, probably by the sulphuric acid which brought the gold. Then the rocks were folded and then oxidation and impoverishment of the upper parts followed to form bonanzas below.

Hills R.C. Proc. of Col. Sci. Soc. Mar. 83. Abstract by S.F. Emmons in the E. & M. Jour. June 9. 1883. p. 332.

Custer Co. affords some of the most interesting deposits in the west. Rosita and Silver Cliff are the principal towns and are situated in the Wet Mountain Valley between the Colorado range on the

Eagle Co. The lead silver mines at Red Cliff have already been mentioned (Type 35a) and also the underlying gold deposits. The Homestake mine north west of Leadville over toward Red Cliff is a vein of galena in granite and one of the first openings made in the region.

Mining Industry Denver. Jan. 10, 1880 p. 38 Battle Mtn. Quartzite Mines Olcott T.K. Battle Mtn. Mining Dist. Eagle Co. Col. E.& M. Jour. June 11 & 18 1887. p. 417 486.

Tilden G.C. Mining Notes from Eagle Co. Col. State Sch. of Mines Ann. Rep. 1888. p. 139.

Summit Co. The Ten Mile District which is the principal one has been mentioned under Type 32b. The Fride of the West Mine on Jacque Mtn. is peculiar being on a quartz porphyry dike which is partly replaced by ferruginous quartz and barite. Lake Co. containing Leadville has been treated under Type 32. Mention should also be made of the placer deposits in California Gulch which first attracted prospectors (1860) to the region. (Type 47).

Type 37a. Park Co. lying east of Lake and embracing the South Park has some mines on the western slopes of the Mosquito Range and in the Colorado Range in its north eastern corner. The latter are similar to the Georgetown silver ores mentioned under Clear Cr. Co. but the former are bodies of argentiferous galena and its alteration products in limestone and quartzite. Pyrite is also abundant and at times a gangue of barite appears. The mines are in the sedimentary series resting on the granite of the Mosquito Range and placed by the [illegible] as at Leadville.

The Placer Deposits at Fairplay deserve mention as it was from these that the prospectors spread over the divide to the site of Leadville in 1860 (See also Type 47).

Jernegan W.L. The Whale Lode of Park Co. Col. M.E. 3. 382.

Chaffee Co. on the south contains the iron mines referred to under Type 12e. There are other gold veins near Granite and Buena Vista. The lead silver deposits of the Alpine district are mentioned under Type 32b. In Hinsdale Co. in the Spanish Peaks veins of galena, grey copper etc. are known and worked to some extent.

Type 37c. Rio Grande Co. On the Summit Dist. are a number of rich gold mines of which the Little Annie is the best known. They occur in the native form, in quartz on the contact between a rhyolite and a trachyte breccia or andesite. The deposits are thought by R.C.Hills to be due to a silicification of the rhyolite along these lines, probably by the sulphuric acid which brought the gold. Then the rocks were faulted and then oxidation and impoverishment of the upper parts followed to form bonanzas below.

Hills R.C. Proc. of Col. Sci. Soc. Mar. 83. Abstract by S.F.Emmons in the E.& M.Jour. June 9. 1883. p.382.

Custer Co. affords some of the most interesting deposits in the west. Rosita and Silver Cliff are the principal towns and are situated in the Wet Mountain Valley between the Colorado range on the

north and the Sangre de Cristo on the south.

Type 37e. At Silver Cliff an outbreak of pinkish rhyolite occurs apparently resting on granite, and impregnated with silver chloride affording a free milling, abundant although rather low grade ore.

Type 37f. Bull Domingo and Bassick. The first named is two miles north of Silver Cliff and the latter seven miles east near Rosita. The Bull Domingo is in Archaean hornblendic gneiss and consists of what appears to be pebbles or boulders of the wall rock coated with argentiferous galena which covers them and is itself further mantled by a silicious shell. The ore body is 40' to 60' wide. The Bassick is in andesite and likewise consists of what appear to be boulders and pebbles of the country rock in an elliptical chimney 20'-100' wide and coated by concentric shells of rich ores. The first is a mixture of lead, antimony and zinc sulphides and is always present. A second somewhat similar but of lighter color and richer in lead and the precious metals is sometimes seen. A third is chiefly zinc blende rich in silver and gold the largest of all . A fourth of chalcopyrite sometimes occurs, and lastly a fifth of pyrite. Various other minerals are found and curiously enough charcoal on the outer limits. Both these deposits have been thought to be the tubes of geysers in which boulders have been tossed about and rounded and finally cemented together. Mr Emmons argues against this view and in the forth-coming Monograph will present the results of more careful study than has yet been given these deposits.

Type 37g. Humboldt-Pocahontas. Fissure veins near Rosita in andesite but of a different flow and kind from the walls of the Bassick, and filled with gray copper and chalcopyrite in a barite gangue. Other mines of less importance occur in the district but the three above cited are given the prominence because of their own intrinsic interest and because they have been often cited in discussions about the origin of ores.

Clark R.N. Humboldt Pocahontas Vein. at Rosita Col. M.E. 7[illegible].
" " Silver Cliff Col. E.& M.Jour. Nov.2.1878. p. 314.
Emmons S.F. The Genesis of Certain Ore Dep. M.E. 15. 146.
" " 10th. Census Vol. 13. p. 80. Rec.
Graybill L.C. On the Peculiar Features of the Bassick Mine M.E. 11. 110. E.& M.Jour. Oct. 28.1882. p. 226. Rec.

Gilpin Co. has already been referred to under copper Type 16b.

Type 37h. Clear Creek Co. Veins along the faulting of jointing planes of gneiss (or granite) or associated with porphyry dikes and more or less a replacement of the walls, and containing argentiferous galena, tetrahedrite and pyrite. They resemble in structural features the veins of Gilpin Co. but are entirely different in their ores. At times the ores seem to impregnate porphyry dikes or pegmatite segregations. Georgetown is the principal town and mining center, the others being Idaho Springs, Silver Plume, and the Geneva Dist.

north and the Sangre de Cristo on the south.

Type 37a. At Silver Cliff an outbreak of pinkish rhyolite occurs apparently resting on granite, and impregnated with silver chlorids affording a free milling, abundant although rather low grade ore.

Type 37f. Bull Domingo and Bassick. The first named is two miles north of Silver Cliff and the latter seven miles east near Rosita. The Bull Domingo is in Archaean hornblendic gneiss and consists of what appears to be pebbles or boulders of the wall rock coated with argentiferous galena which covers them and is itself further mantled by a siliceous shell. The ore body is 40' to 60' wide. The Bassick is in andesite and likewise consists of what appear to be boulders and pebbles of the country rock in an elliptical chimney 20'-100' wide and coated by concentric shells of rich ores. The first is a mixture of lead, antimony and zinc sulphides and is always present. A second somewhat similar but of lighter color and richer in lead and the precious metals is sometimes seen. A third is chiefly zinc blende rich in silver and gold the largest of all . A fourth of chalcopyrite sometimes occurs, and lastly a film of pyrite. Various other minerals are found and curiously enough charcoal on the outer limits. Both these deposits have been thought to be the tubes of geysers in which boilers have been tossed about and rounded and finally cemented together. Mr Emmons argues against this view and in the forth-coming monograph will present the results of more careful study than has yet been given these deposits.

Type 37g. Nambold-Pescadores. Pleasure veins near Rosita in andesite but of a different flow and kind from the walls of the Bassick, and filled with gray copper and chalcopyrite in a barite gangue. Other mines of less importance occur in the district but the three above cited are given the prominence because of their own intrinsic interest and because they have been often cited in discussions about the origin of ores.

Clark R.N. Humboldt Pescadores Vein. at Rosita Col. M.D. 1881.
" " Silver Cliff Col. E.& M.Jour. Nov.8.1879. p. 314.
Emmons S.F. The Genesis of Certain Ore Dep. M.M. 18. 146.
" " 10th. Census Vol. 15. p. 80. Rep.
Greyhill D.C. On the Peculiar Features of the Bassick Mine M.M. 11. 110. E.& M.Jour. Oct. 25.1882. p. 285. Rep.

Gilpin Co. has already been referred to under copper Type 16b.

Type 37h. Clear Creek Co. Veins along the faulting of jointing planes of gneiss (or granite) or associated with porphyry dikes and more or less a replacement of the walls, and containing argentiferous galena, tetrahedrite and pyrite. They resemble in structural features the veins of Gilpin Co. but are entirely different in their ores. At times the ores seem to impregnate porphyry dikes or pegmatite segregations. Georgetown is the principal town and mining center, the others being Idaho Springs, Silver Plume, and the Geneva Dist.

[illegible] Parallel Survey. Vol. III.
Emmons S.F. 10th Census. Vol. 13. p.70. Rec.
Hague J.D. 40th. Parallel Survey Vol. III, p.589.
Vinton F.L. The Georgetown Col.Mines. E.& M.Jour. Sept.13/1879p.184.

Type 37h. Boulder Co. Veins along joints or faulting planes in gneiss or granite or associated with porphyry dikes or pegmatite segregations and carrying tellurides of the precious metals more of less as an impregnation of the country rock. The prevalent country rock is called by Emmons a granite-gneiss. Van Diest (l.c.) distinguishes four successive terranes of massive and schistose rocks folded along three principal axes and two side ones, and states that the mines are on the slopes of the folds. The country is very generally pierced by porphyry dikes with which the ore bodies are often associated. A large number of species of telluride minerals have been determined from the region especially by Dr. Genth of Philadelphia. The mines afford very rich ores, somewhat irregularly distributed.

Eilers.A.A new Occurrence of the Telluride of Gold and Silver M.E. 1. 316.
Emmons S.F. 10th. Census Vol. 13. p.64.
Genth F.A. On Tellurides. A.J.S.II. 45. 305 & other later papers in in the same Journal.
Van Diest.P.H. The Mineral Res. of Boulder Co. Ann. Rept. Col. State Sch. of Mines. 1886. p. 25.

The resources of the remaining counties of Col. are chiefly in coal which will be spoken of in its place.

Wyoming.Geology explained at length. The production of Wyoming in the precious metals is insignificant as yet. Several years ago (1867) the Sweetwater region attracted attention but it has not been of much importance since. Mines may be opened up in time in the mountainous western portion of the Teritory. The eastern part is prairie or plateau country. The resources in coal are very great (See later under coal) and iron is known (See Type 13e) and copper has been produced in some quantity (See Type 20g).
Emmons S.F.10th.Census Vol. XIII. p.86.
Raymond R.W. Mining Statistics West of the Rocky Mountains.

Type 38. Black Hills, S. Dak. Geology explained at length. The principal product of the Black Hills at present is gold. The lead-silver deposits have been referred to above (Type 33a) and the tin deposits, mica etc. will be mentioned later. The gold occurs in placers (See Type 47) of Quaternary and Recent age as well as in Potsdam sandstones (Compare Type 45a) which are old shore beaches now hardened to rock; in pyritous beds in schistose rocks and in segregated quartz veins. (Cf. Type 48). The Quaternary and recent placers are the usual gravels which are more fully described under Cal., The Potsdam Sandstone is an extremely interesting deposit. It has resulted from the wearing action of the waves of the

...Geol. Canada Surv., Vol. III,
Memoir 4-E, 1913. Ontario, Vol. 18, p. 75, 1909.
Negus J.D. 40th. Parallel Survey Vol. III, p.1877.
Winton P.L. The Geographic Set.Mines. N.S. N.Scot., Rept.1915/1919.1921.

Type 37a. Boulder Co. Veins along joints or fracture planes in granite or gneiss or associated with porphyry dikes or pegmatite segregations and carrying tellurides of the precious metals were of less as an importance of the country rock. The prevalent country rock is faulted by Mesozoic & Tertiary-Quaternary. The Black (J.S.) district includes three successive generations of mineral and pegmatites dikes folded along three principal axes and two side axes, and strikes that the mines are on the slopes of the rocks. The country is very generally planed by pediment dikes with which the ore bodies are often associated. A large number of specimen of telluride minerals have been determined from the region especially by Dr.Gonth of Philadelphia. The values differed very much even, sometimes irregularly distributed.

Miers.A.M.A new occurrence of the Telluride of Gold and Silver M.M. 1. 212.

Memoirs S.P. 10th. Geology Vol. 12. p.62.

Genth F.A. On Tellurides. A.J.S.II. 42. 305 & other later papers in in the same journal.

Van Diest.T.H. The Mineral Res. of Boulder Co. Ann. Rept. Col. State Bur. of Mines. 1888. p. 82.

The resources of the remaining counties of Col. are unlikely in coal which will be spoken of in its place.

Wyoming.Geology explained at length. The production of Type-mine in the precious metals is insignificant as yet. Several years ago (1887) the Sweetwater region attracted attention but it has not been of much importance since. Mines may be opened up in time in the mountainous western portion of the Territory. The eastern part is prairie or plateau country. The resources in coal are very great (See later under coal) and iron is known (See Type 15a) and copper has been produced in some quantity (See Type 32g).
Memoirs S.G.10th.Census Vol. XVII. p.86.
Raymond R.W. Mining Statistics West of the Rocky Mountains.

Type 38. Black Hills. S. Dak. Geology explained at length. The principal product of the Black Hills at present is gold. The lead-silver deposits have been referred to above (Type 32a) and the tin deposits, which will be mentioned later. The gold occurs in placers (See Type 34) of Quaternary and Recent age as well as in Potsdam sandstone(Cambrian Type 32e) which are old shore beaches now inclined to the east. It persists down in metalliferous veins and in segregated quartz veins. (Cf. Type 36). The Quaternary and recent placers are the usual gravels which are more fully described under Col.. The Potsdam Sandstone is an extremely interesting deposit. It has resulted from the wearing action of the waves of the

Potsdam ocean on the Archaean schists. The Potsdam also carries other deposits in the vicinity of porphyry sheets and dikes, which consist of auriferous pyrite, sometimes oxidized which has replaced the original calcareous cement of the quartzite. The pyritous beds are in a broad impregnated zone 2000' broad (Carpenter) of slates and schists with portions especially rich in auriferous pyrites. The ore is not of high grade running $3-$4.00 per ton but it is treated at great profit by mining it in enormous quantities.

In 1883 at the Homestake 243,335 tons were mined yielding $3.68 gold per ton and 0.03 silver at a profit of $1.19 per ton. This of course is only attainable in an excellently organized and managed enterprise. (Compare in this connection the occurrence of gold in the Southern States, Type 49). There are also many so called segregated quartz veins, in the schists and slates. These are lenticular masses of limited extent horizontally and below (some what like a magnetite lense Type 13 in shape), and carrying a small amount of gold with little or no pyrites (See Cal. Type 48) (Views and Sections).

Bowie A.J. Notes on Gold Mill Construction M.E. 10. 1887.
Carpenter F.B. Prelim. Rep. on the Geol. of the Black Hills Rapid City. Dak. 1888.
" Ore Dep. of the Black Hills. M.E. 17. 570. Rec.
Devereux W.B. The Occurrence of Gold in the Potsdam Formation. M.E. 10. 465. E.& M.J. Dec. 23. 1882. p. 334:.
Emmons S.F. 10th Census Vol. 13. p.89 Rec, See also under Tin.
Hofman H.O. Gold Milling in the Black Hills. M.E. 17. 498. Also in Prelim. Rep. cited under Carpenter.
Newton & Jenney. Rept. on the Black Hills Wash. 1880.

Type 39. Montana. Geology and geography described at length. Montana took the lead of all the states in 1887 in the production of silver and was second in gold and first in the total production of the two. In its mineral wealth it yields to no other state in the Union. The mining districts are mostly in the western central and western portions of the state. The Rocky Mtns. are lower in Mont. than in Col. and broad valleys suitable for agriculture and as a rule well watered add to its advantages. Developments have progressed so rapidly in Montana that all the desirable data are not available.

Type 39a. Madison Co. Veins in gneiss containing galena and pyrite in a quartz gangue. Virginia City is the principal town and the veins are north of it in the northern portion of the count Emmons S.F. 10th. Census Vol. XIII p.97.

Type 39b. Beaverhead Co. Near Bannack City quartz veins with auriferous pyrite on the contact between limestone and so called granite. At Glendale in the northern part of the county are the Hecla mined referred to under lead silver (Type 33) Auriferous quartz veins are reported further north.
Emmons S.F. 10th. Census Vol. XIII . 97;

Potsdam ocean on the Archaean sediments. The Potsdam also carries other deposits in the vicinity of porphyry dikes and dikes, which consist of auriferous pyrite, sometimes oxidized which has replaced the original calcareous cement of the quartzite. The pyritous beds are in a broad impregnated zone 2000' broad (Carpenter) or plates and sohists with porphone especially rich in auriferous pyrites. The ore is not of high grade running $5-$6.00 per ton but it is treated at great profit by mixing it in enormous quantities.

In 1883 at the Homestake 245,350 tons were mined yielding $3.82 gold per ton and 0.03 silver at a profit of $1.19 per ton. This of course is only attainable in an exceptionally organized and managed enterprise. (Compare in this connection the occurrence of gold in the Southern States, Type 49). There are also many so called segregated quartz veins, in the schists and slates. These are lenticular masses of limited extent horizontally and below (some what like a magnetite lense Type 13 in shape), and carrying a small amount of gold with little or no pyrites (See Cal. Type 45) (Views and Sections).

Bowie A.J. Notes on Gold Mill Construction M.E. 10. 1887.
Carpenter F.B. Prelim. Rep. on the Geol. of the Black Hills Rapid City, Dak. 1888.

" Ore Dep. of the Black Hills. M.E. 17. 570. Rep.
Devereux W.B. The Occurrence of Gold in the Potsdam Formation. M.E. 10. 485. E.& M.J. Dec. 24. 1882. p. 384.
Emmons S.F. 10th Census Vol. 13. p.89 Rep. See also under Tin.
Hofman H.O. Gold Milling in the Black Hills. M.E. 17. 498. Also in Prelim. Rep. stated under Carpenter.
Newton & Jenney. Rept. on the Black Hills Wash. 1880.

Type 39. Montana. Geology and geography described at length. Montana took the lead of all the states in 1887 in the production of silver and was second in gold and first in the total production of the two. In its mineral wealth it yields to no other state in the Union. The mining districts are mostly in the western central and western portions of the state. The Rocky Mts. are lower in Mont. than in Col. and broad valleys suitable for agriculture and are quite well watered add to its advantages. Development has progressed so rapidly in Montana that all the desirable data are not available.

Type 39a. Madison Co. Veins in gneiss containing galena and pyrite in a quartz gangue. Virginia City is the principal town and the veins are north of it in the northern portion of the county
Emmons S.F. 10th. Census Vol. XIII p.87.

Type 39b. Beaverhead Co. Near Bannack City quartz veins with auriferous pyrite on the contact between limestone and no called granite. At Glendale in the northern part of the county are the Noble mines referred to under lead silver (Type 33) Auriferous quartz veins are reported further north.
Emmons S.F. 10th. Census Vol. XIII p. 87.

Type 39c. Jefferson Co. The county contains ore bodies chiefly auriferous quartz in gneiss, porphyry or limestone. The lead silver mines near Wickes have been referred to (Type 33).
Emmons S.F. 10th. Census Vol. XIII p. 97.

Type 39d. Silver Bow Co. The copper mine and the general geology of the Butte City region were referred to under copper (Type 17). In the basic granite and north of the copper zone is a belt of veins carrying sulphides of silver lead, zinc and iron in a silicious gangue but abundantly associated with manganese compounds of various sorts, especially rhodonite. No manganese is known in the copper belt, nor any copper in the silver belt, a most striking phenomena in veins in the same wall rock. Here occur the Alice, Lexington and Moulton Mines. In the more acid granite west of the Butte, is another silver belt with the silver minerals as in the other veins and likewise in a gangue of manganese minerals.

The Blue-bird is the principal mine of this zone. The manganiferous outcrop of these veins was a notable feature in the landscape being a broad rusty black belt, not very rich on the surface and only showing the silver in depth. The Gagnon vein, however, lacks manganese quite entirely and contains other curious minerals as described by Mr Pearce. Emmons argues strongly that these veins were formed along circulation fissures, probably of small original size but afterwards much enlarged by a replacement of the walls with ores. Placer mines have also been worked near Butte.
Blake W.P. Silver Mining & Milling at Butte Mont. M.E.16 38
" " The Rainbow Lode. Butte City Mont. M.E. 16. 65.
Emmons S.F. Notes on the Geol. of Butte Mont. M.E. 16.49. p.208
Pearce Rich. The association of Minerals in the Gagnon Vein Butte City M.E. 16. 62.
Peters E.D. Min. Res. U.S. 1883-84 p.374.
Spilsbury E.G. Placer Mining in Mont. E.& M.J. Sep. 3. 1887 p.167. Rec
" The Silver Mines of Butte Mont. April 18 1885. p.261.
Williams & Peters On Butte Mont. E.& M.Jour. Mar 28. 1885. p.208.

Type 39e. Deer Lodge Co. Placer deposits (Type 49) are numerous along the Deer Lodge River, and auriferous quartz veins are known, but the greatest mine is the Granite Mtn. now yielding very handsome returns. This is in the southern part of the county near Phillipsburg and is a fissure vein in granite, principally with silver ores and considerable gold. On the same vein is the Bimetallic. Further west sedimentary rocks come in much metamorphosed by contact with later eruptive granite.
Goodale C.W.& Akes W.A. Concentration etc. with notes on the Geol. of the Flint Creek Mining Dist. M.E. 1890 Rec.
E.& M.J. The Granite Mtn. Mine. Dec.10 1887.-Nov. 23. 1889.
Spilsbury E.G. Placer Mining in Mont. E.& M.J. Sep. 3.87. p.167.

Type 39f. Lewis & Clark Co. The placer mines (Type 47) near Helena (Last Chance and Prickly Pear Gulches) which were found by the prospectors who spread through the Rocky Mtns. as the Cal. gold

Type 389. Jefferson Co. The county contains ore bodies chiefly auriferous quartz in gneiss, porphyry or limestone. The lead silver mines near Wickes have been referred to (Type 33).
Emmons S.F. 10th. Census Vol. XIII p. 97.

Type 390. Silver Bow Co. The copper mine and the general geology of the Butte City region were referred to under copper (Type 17). In the basic granite and north of the copper zone is a belt of veins carrying sulphides of silver lead, zinc and iron in a siliceous gangue but abundantly associated with manganese compounds of various sorts, especially rhodonite. No manganese is known in the copper belt, nor any copper in the silver belt, a most striking phenomena in veins in the same wall rock. Here occur the Alice, Lexington and Moulton Mines. In the more sand granite west of the Butte, is another silver belt with the silver minerals as in the other veins and likewise in a gangue of manganese minerals.

The Blue-bird is the principal mine of this zone. The manganiferous exterop of these veins was a notable feature in the landscape being a broad rusty black belt, not very rich on the surface and only showing the silver in depth. The Gagnon vein, however, looks manganese quite entirely and contains other ore-ious minerals as described by Mr Pearce. Emmons argues strongly that these veins were formed along circulation fissures, probably of small original size but afterwards much enlarged by a replacement of the walls with ore. Placer mines have also been worked near Butte.
Blake W.P. Silver Mining & Milling at Butte Mont. M.E.16 38
The Rainbow Lode. Butte City Mont. M.E. 16. 68.
Emmons S.F. Notes on the Geol. of Butte Mont.M.E. 16.49. p.308
Pearce Rich. The associations of Minerals in the Gagnon Vein Butte City M.E. 16. 63.
Peters E.D. Min. Res. U.S. 1883-84 p.374.
Spilsbury E.G. Placer Mining in Mont. E.& M.J. Sep. 3. 1887 p.187 Re
The Silver Mines of Butte Mont. April 18 1885. p.261.
Williams & Peters On Butte Mont. E.& M.Jour. Mar 28. 1885. p.205.

Type 391. Deer Lodge Co. Placer deposits (Type 49) are numerous along the Deer Lodge River, and auriferous quartz veins are known, but the greatest mine is the Granite Mtn. now yielding very handsome returns. Type is in the southern part of the county near Philipsburg and is a fissure vein in granite, principally with silver ores and considerable gold. On the same vein is the Bimetallic. Further west sedimentary rocks come in much metamorphosed by contact with later eruptive granite.
Goodale C.W.& Alden W.A. Concentration etc. with notes on the Geol. of the Flint Creek Mining Dist. M.E. 1890 Feb.
E.& M.J. The Granite Mtn. Mine. Dec.10 1887. Nov. 25. 1888.
Spilsbury E.G. Placer Mining in Mont. E.& M.J. Sep. 3.87. p.187.

Type 392. Lewis & Clark Co. The placer mines (Type 47) near Helena (last Chance and Prickly Pear Gulches) which were found by the prospectors who spread through the Rocky Mtns. as the Cal. gold

diggings gave out, were the first to attract attention. Later many auriferpus quartz veins in granite and slates have been developed. Some 20 miles north of Helena is the Drumlummon Group of veins carrying refractory silver and gold ore in a quartz gangue on the contact between a granite knob and the surrounding metamorphic schists. There are also other veins in the granite and dikes of eruptive rock occur associated with the ore bodies.

Clayton J.D. The Drumlummon Group of Veins, etc. E.& M. Jour. Aug. 4 & 11 1888. pp. 85,& 106.

Emmons S.F. 10th Census Vol. XIII. p.97.

Missoula Co. in the northwestern corner of the state is a region of later developments, especially since the N.Pac. R.R. has been built through it. At Iron Mtn. and elsewhere mining districts are growing up, but available descriptions have not yet been received.

Idaho

Type 40. Geography and Geology explained at length.

The southern part of the territory partakes of the character of the Great Basin (See p.5), north of this in the Snake River Valley is an immense outpouring of basalt. The northern part of the state is on the western slopes of the Rocky Mtns, and is mountainous and varied in topography. In the most northern county Kootenie, gold-quartz veins and placers are recorded but available and accurate descriptions are yet to be placed in print. In Shoshone Co. are the rich Coeur d' Alene lead silver mines, already referred to under Type 34a. Nez Perces Counties (Wash. and Idaho) are also known to contain gold quartz and placers. Lemhi Co. is in the central part of the territory on the western slopes of the Rocky Mtns. Its mines are chiefly placers along the Salmon River, Custer Co, south of Lemhi contains several well known mines(Ramshorn, Charles Dickens, Custer etc.). These are in metamorphic rocks, (gneiss slate etc.) with associated porphyry at the Custer, and contain various gold and silver ores.

The Custer vein is a great ledge with silver sulphides and less abundant gold. The Charles Dickens produces gold and silver in about equal amounts. Smelting ores also occur in the region, as in the Ramshorn and other mines in which small smelting operations have been carried on. In Boisé and western Alturas Co's. a granite area forms the greater part of the surface, and in it are numerous productive veins. In the former they come chiefly gold quartz except in the Banner district where silver predominates. The placer deposits of the county which were developed in 1863 were very rich but are now less productive than in former years. In Alturas Co. the same gold quartz veins occur, and also others carrying silver, and the county is a strong producer. The Wood River Mines in slates and limestones, south east of the granite have already been referred to ,Type 34. Owyhee Co. is in the south western corner. It is probable that the granite of the two last mentioned extends under overlying drift and comes up again near Silver City (Becker). South west of it quartz porphyry and metamorphic rocks are found

Type 40. Geography and Geology explained at length.

The southern part of the territory partakes of the character of the Great Basin (See p.8), north of this in the Snake River Valley is an immense outpouring of basalt. The northern part of the state is on the western slopes of the Rocky Mtns. and is mountainous and varied in topography. In the most northern county, Kootenai, gold-quartz veins and placers are reported but available data accurate descriptions are yet to be placed in print. In Shoshone Co. are the rich Coeur d' Alene lead silver mines, already referred to under Type 3aa. Not far from Wallace are also known to contain gold quartz and placers, Lemhi Co. in the central part of the territory on the western slopes of the Rocky Mtns. Its mines are chiefly placers along the Salmon River, Custer Co. south of Lemhi containing several well known mines(Ramsdorn, Charles Dickens, Custer etc.).

These are in metamorphic rocks, (gneiss slate etc.) with muscovite porphyry at the Custer, and contain various gold and silver ores. The Custer vein is a great ledge with silver sulphides and less abundant gold. The Charles Dickens produces gold and silver in about equal amounts. Smelting ores also occur in the region, as in the Ramsdorn and other mines in which small smelting operations have been carried on. In Boise and western Alturas Co's, a granite area forms the greater part of the surface, and in it are numerous productive veins. In the former they are chiefly gold quartz except in the Banner district where silver predominates. The placer deposits of the county which were developed in 1863 were very rich but are now less productive than in former years. In Alturas Co. the same gold quartz veins occur, and also others carrying galena, and the county is a strong producer. The Wood River Mines in slates and limestones, south east of the granite have already been referred to, Type 3a. Owyhee Co. is in the south western corner. It is probable that the granite of the two last mentioned extends under overlying drift and comes up again near Silver City (Custer). South west of it quartz porphyry and metamorphic rocks are found

and dikes of basalt. Gold quartz and high grade silver ores are the ones present. The Poorman Lode is a famous one for ruby silver ores. W.P.Blake mentions seeing a piece from this mine at the Paris exposition which weighed about 200 lbs. (A.J.S. II. 45. 197).

In Cassia and Oneida two other counties in the southern part placers are or have been worked and in Bear Lake Co. in the south east corner salt and sulphur deposits are recorded.

Becker G.F. 10th Census Vol XIII. p.59
Report of the Director of the Mint 1882 p. 227.

The Colorado Plateau and the Great Basin Region. (Part of Idaho belongs here).

Type 41. Utah. Geology and geography explained at length. The greater number of the Utah mines have been mentioned under Type 29 and 30. The north western county, Box Elder, in the alkaline desert region of the Great Basin. Then down through the central part of the state in the Wahsatch and Oquorrh mountains the mining districts occur, and in the extreme south west,

Type 41a. Ontario Mine. Nearly east of Salt Lake City in Summit Co. is the Ontario Mine, a vein from 4' to 28' wide averaging 8', in quartzite, but extremely persistent, being opened continuously for 6000'. In the lower workings a porphyry dike has come in as one of the walls. The ores consist of galena, gray copper, silver glance, blende etc.. The best grade runs about $95, the second about $50. The mine has been finely managed from the start and is one of the most creditable enterprises in the west. Other somewhat similar ore bodies are known in the same region but are less developed.

Almy T.J. History of the Ontario Mine. Park City Utah M.E.16. 35.
E.& M.J. The Ontario Mine May 28. 1881. p.365.
Huntley D.B. 10th. Census Vol. XIII p.438.

The lead silver bedded veins of Bingham Canon, in Salt Lake Co. have already been mentioned, Type 29. Reference may again be made to the great bed of gold quartz associated with them. Ophir and Dry Canons in Tooele Co; Type 29a have also been described, and the Tintic Dist in Juab Co.(Types 20h and 29b). In addition to the smelting ores others have been treated by milling. In Beaver Co. the interesting deposits of the Hornsilver, the Carbonate and the Cave ore bodies have been mentioned under Types 30, 30a and 30b. The great iron mines of Iron Co. will be found under Type 14.(1)

In Piute Co. near the town of Marysvale, around Mt. Baldy are a number of mines with lead silver or milling ores, in quartz porphyry (Copper Belt) or between limestone and quartzite.(Deer Trail, Greeneyed Monster etc.).

Type 41b. Silver Reef Utah. Native silver, cerargerite and argentite impregnating Triassic sandstones and often replacing organic remains. These deposits were referred to under Type 21c. They were discovered in 1877. At Silver Reef, there are two silver

and dikes of basalt. Gold quartz and high grade silver ores are the ones present. The Rockwell Lode is a famous one for ruby silver ores. W.P.Blake mentions seeing a piece from this mine at the Paris exposition which weighed about 200 lbs. (A.J.S. IX, 49, 187).

In Cassia and Oneida two other counties in the southern part of the state in the Wahsatch and Uquawrh mountains the mining districts occur, and in the extreme south west,

Type 41a. Ontario Mine. Nearly east of Salt Lake City in Summit Co. is the Ontario Mine, a vein from 4' to 25' wide averaging $4, in quartzite, but extremely persistent, being opened continuously for 6000'. In the lower workings a porphyry dike has come in as one of the walls. The ores consist of galena, gray copper, sulphur, blende etc.. The best grade runs about $35, the second about $20. The mine has been finely managed from the start and is one of the most creditable enterprises in the west. Other occurrences similar ore bodies are known in the same region but are less developed.

Army T.v. History of the Ontario Mine. Park City Utah M.M.IG. 35.
E.& M.J. The Ontario Mine May 28, 1881. p.365.
Hunsley T.B. 10th. Census Vol. XIX p.459.

The lead silver bedded veins of Bingham Canon, in Salt Lake Co. have already been mentioned, Type 39. Reference may again be made to the great bed of gold quartz associated with them. Ophir and Dry Canons in Tooele Co. Type 39a have also been described, and the Tintic Dist. in Juab Co. (Types 20h and 29b). In addition to the smelting ores others have been treated by milling. In Beaver Co. the interesting deposits of the Horn silver, the Carbonate and the Cave ore bodies have been mentioned under Types 30, 30a and 30b. The great iron mines of Iron Co. will be found under Type 1a.(1)

In Piute Co. near the town of Marysvale, around Mt. Belly are a number of mines with lead silver or milling ores, in quartz porphyry (Copper Belt) or between limestone and quartzite. (Deer Trail, Greenleaf Monster etc.).

Type 41b. Silver Reef Utah. Native silver, cerargyrite and argentite impregnating triassic sandstones and often replacing organic remains. These deposits were referred to under Type 21c. They were discovered in 1877. At Silver Reef, there are two silver

bearing strata or reefs, with beds of lower clay shale between. Above the water line the ore is hornsilver, below, it is argentite. At times it replaces plant remains, at other times no visible presence of ore can be noted although the rock may afford $30,00 to the ton. The silver always occurs along certain ore channels, distributed through certain parts of the sandstone. The origin of these deposits has given occasion to a vigorous discussion. J.S.Newberry holds that the silver was deposited in and with the sandstone from the Triassic sea, although it may have been concentrated since in the ore channels, F.M.F.Cazin holds that the organic remains were deposited in and with the sandstone and that these were the immediate precipitating agents of the ores. R.P.Rothwell explained them much as does Rolker below.

C.M.Rolker, who was for some years in charge of several of the mines, has also written about them and is probably nearest to the truth. Rolker argues that the impregnation was subsequent to the formation and was caused by the igneous outbreaks in the neighborhood and probably is along old lines of partial weakning or crushing that afterwards healed up. Eruptive rocks are known in the neighborhood both in Utah and in the Nacemiento Copper district of New Mexico. From what we know of ore deposition in general this seems most probable.

Cazin F.M.F. The Origin of the Copper and Silver Ores in Triassic Sandstone. E.& M.J. Dec.11.'80. p.381. Apr. 30.'81. p.300.
E.& M.J. The Silver Sandstone Formation at Silver Reef. May 22. 1880. p.351. Jan. 10,17,& 24. 1880 pp.25, 48 & 79 (Rothwell)
Jackson A.N. Silver in Sedimentary Sandstone Rept. of Director of the Mint 1888. p.384 quoting Cal. Acad. Sci.
Newberry J.S. Rept. on the Properties of the Stormont Silver Mining Co. etc. E.& M.J. Oct.23. 1880 p.269.
" " The Silver Reef Mines. E.& M.J. Jan.1.1881. p.4.
Rolker C.M. The Silver Sandstone Dist.of Utah M.E. 9. 21.

Type 42. Arizona .Geology and geography explained at length. The rainfall is slight and the country lacks water. The north eastern portion comes into the plateau district but is largely by Jura Trias and Carboniferous strata. In the south east it is mountainous and rich in mining districts (See Type 20). The same is true of the central and north eastern but the south western is a sandy desert and probably the hottest portion of the U.S..

Apache Co. is in the north eastern corner. In the southern part of the county gold and silver ores, in veins in limestone associated with copper ores are reported and some small placers. Yavapai Co. Gold and silver ores in quartz veins in granite and metamorphic rocks. The Black Range copper district has already been referred to under Type 20) Mohave Co. Silver sulphides, arsenides etc. and alteration products above the water level (low grade sulphides below) in veins in granite at times showing a

bearing strata or rocks, with beds of lower clay shale between. Above the water line the ore is horn silver, below, it is argentite. At times it replaces plant remains, at other times no visible presence of ore can be noted although the rock may afford $50.00 to the ton. The silver always occurs along certain ore channels, distributed through certain parts of the sandstone. The origin of these deposits has given occasion to a vigorous discussion. J.S.Newberry holds that the silver was deposited in and with the sandstone from the Triassic sea, although it may have been concentrated since in the ore channels, T.M.T.Cosin holds that the organic remains were deposited in and with the sandstone and that these were the immediate precipitating agents of the ores. R.P.Rothwell [illegible] Raton Region, Colorado.

G.M.Rolker, who was for some years in charge of several of the mines, has also written about them and is probably nearest to the truth. Rolker argues that the impregnation was subsequent to the formation and was caused by the igneous outbreaks in the neighborhood and probably is along old lines of partial weathering or crushing that afterwards healed up. Eruptive rocks are known in the neighborhood both in Utah and in the Tascosa to Copper district of New Mexico. From what we know of ore deposition in general this seems most probable.

Cosin T.M.T. The Origin of the Copper and Silver Ores in Triassic Sand. Mask. E.& M.J. Dec.11.'80. p.381, Apr. 30.'81, p.300.

E.& M.J. The Silver Sandstone Formation at Silver Reef, May 22. 1880. p.361. Jan. 10,17,& 24. 1880 pp.25, 48 & 73. Mass.

Jackson A.M. Silver in Sedimentary Sandstone Rept. of Director of the Mint 1888. p.388 quoting Cal. Acad. Sci.

Newberry J.S. Rept. on the Properties of the Stormont Silver Mining Co. etc. E.& M.J. Oct.23. 1880 p.289.

The Silver Reef Mines. E.& M.J. Jan.1.1881. p.4.

Rolker G.M. The Silver Sandstone Dist. of Utah M.E. 9, 21.

Type 48. Arizona. Geology and geography explained at length. The rainfall is slight and the country lacks water. The north eastern portion comes into the plateau district but is largely by Tertiaries and Carboniferous strata. In the south east it is mountainous and rich in mining districts (See Type 20). The same is true of the central and north western but the south western is a sandy desert and probably the hottest portion of the U.S..

Apache Co. is in the north eastern corner. In the southern part of the county gold and silver ores, in veins in limestone associated with copper ores are reported and some small placers. Yavapai Co. Gold and silver ores in quartz veins in granite and metamorphic rocks. The Black Range copper district has already been referred to under Type 20) Mohave Co. Silver sulphides, arsenides etc. and alteration products above the water level (low grade sulphides below) in veins in granite at times showing a

gneissoid structure. Only the richest can now be worked. Yuma Co. Quartz veins with silver ores and lead minerals in metamorphic rocks (gneiss, slate etc.) or in granite. Maricopa Co. contains both Palaeozoic and Archaean exposures. The ore deposits lie mostly along the contact of the two, in granite or highly metamorphosed strata. They are usually quartz veins with silver ores and copper, lead and zinc minerals. The Globe Dist. extending also into Pinal Co. is the principal one. Mention has already been made of it under copper (Type 20). Pinal Co. adjoins Maricopa on the south and contains a number of important mines. They produce mostly silver ores with lead and copper associates, and some blende. The gangue minerals are quartz ,calcite etc. occasionally manganese compounds and sometimes in the granites, barite. Limestone, slate, sandstone and quartzite as well as granite, diabase and diorite occur as wall rocks.

Type 42a. The Silver King Mine. A central mass or chimney of quartz with innumerable radiating veinlets of the same carrying rich silver ores and native silver, in a great dike of feldspar porphyry, with associated granite, syenites (Blake), porphyry gneiss and slates, all of Archaean age. The veinlets ramify through the strongly altered porphyry and form a stockwerk which furnishes the principal ore. In the region are also Palaeozoic strata whose upper limestone beds are referred by Blake to the Carboniferous.

The minerals at tha mines are native silver, stromeyerite, argentite, sphalerite, galenite, tetrahedrite, bornite, chalcopyrite, pyrite, quartz, calcite, siderite, barite.(Views and sections from Blake). Graham Co. contains the Clifton Copper district referred to under Type 20. Cochise Co. is the southeastern Co. and contains the Tombstone Dist., the most productive of the precious metals in the territory.

Type 24b. Tombstone. A great porphyry dike up to 70 feet wide cutting folded Palaeozoic strata and itself extensively faulted, and altered, and carrying above the waterline in numerous vertical joints or partings, quartz with free gold, hornsilver and a little pyrite, galenite and lead carbonate. Curiously enough in the porphyry itself and far from the quartz veins, flakes and scales of free gold have been found evidently introduced in solutoin. Ore also occurs along the sides of the dike. There are also other fissures parallel with this principal dike, and still another series crossing these and the axis of the great anticline of the district. Connected with these fissure veins are bedded deposits in the limestone, along the bedding planes or dropping from one to another, appearing to have originated by replacement. Blake offers two explanations of the first mentioned dike deposit. Either that the dike itself held the precious metals or that they came from the pyrite of the adjoining strata. Considerable manganese occurs in many of the mines. There are several other mining districts of less note in the country, and the copper deposits of the Bisbee region have already been mentioned under Type 20b.

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Type 22a. The Silver King Mine. A central mass or chimney of quartz with innumerable radiating veinlets of the same carrying rich silver ores and native silver, in a great dike of feldspar porphyry, with associated granite, aplanites (Blake), porphyry gneiss and slates, all of Archaean age. The veinlets reach through the strongly altered porphyry and form a stockwork which furnishes the principal ore. In the region are also Palaeozoic strata whose upper limestone beds are referred by Blake to the Carboniferous.

The minerals at the mines are native silver, stromeyerite, argentite, sphalerite, galenite, tetrahedrite, bornite, chalcopyrite, pyrite, quartz, calcite, aiderite, barite. (Views and sections from Blake). Graham Co. contains the Clifton Copper district referred to under Type 2a. Cochise Co. is the southeastern Co. and contains the Tombstone Dist., the most productive of the precious metals in the territory.

Type 23b. Tombstone. A great porphyry dike up to 70 feet wide cutting folded Palaeozoic strata and itself extensively faulted, and altered, and carrying above the watertine in numerous vertical joints carbonates, quartz with free gold, horn silver and a little pyrite, galenite and lead carbonate. Curiously enough in the porphyry itself and far from the quartz veins, flakes and scales of free gold have been found evidently introduced in solution. Ore also occurs along the sides of the dike. There are also other fissures parallel with this principal dike, and still another series crossing these and the axis of the great anticline of the district. Connected with these fissure veins are bedded deposits in the limestone, along the bedding planes or dropping from one to another, appearing to have originated by replacement. Blake offers two explanations of the first mentioned dike deposit. Either that the dike itself held the precious metals or that they came from the pyrite of the adjoining strata. Considerable manganese occurs in many of the mines. There are several other mining districts of less note in the country, and the copper deposits of the Blabee region have already been mentioned under Type 20b.

Pima Co. is the central one of the southern tier and has Tucson as its principal city. There are numbers of mines of the precious metals and a few less important copper deposits.
Yuma Co. in the southwestern corner has some mines along the Colorado River on quartz veins in metamorphic rocks, containing silver and lead minerals.

Becker G.F. 10th Census Vol XIII p.44.
Blake W.P. The Geology of Tombstone Arizona M.E. 10. 334.
E.& M.J. June 24. 1882. p.328.
The Silver King Mine. Ashort Monograph. New Haven. March 1885 Rec. See also E.& M.J. April 22. 1882. p.238.
Blandy J.F. The Mining Region around Prescott Ariz. M.E. 11. 286.
E.& M.Jour. On Tombstone Ariz. May 7. 1881. p.316. Mar 18. 82.p/4
Silver in Ariz. General Review Sep.21 & 25. 1880 pp172.20
Central Arizona April 23. 1881. p.285.
Silliman B. Rept. on the Mining Dist. of Arizona near the Rio Colorado. A.J.S. II. 41. 289. See also M.& M.Jour. Aug. 11 1877. p.111.

Type 43. Nevada. Geography and geology explained at length. Note the Great Basin with the subordinate north and south ranges largely of eruptive rocks.

Lincoln Co. is in the southeastern corner, and contains a number of small mining districts. The ores are in general silver lead ores in limestone or veins with sulphuret ores in quartzite and granite. Pioche is one of the principal towns near which the once famous Raymond & Ely Mine is located. The Pahranagat and Tom Pahute districts still further south have had some prominence, but the whole region is so far from lines of transportation that the conditions are hard ones.

Type 43a. Ney Co. next west has an important mining center in its northern portion, around the town of Belmont. Quartzites and slates rest on granite in the order named and in them are veins with quartz gangue and silver chlorides affording very rich ores.

Southeast of Belmont is Tybo.

Emmons S.F. Survey of the 40th Parallel Vol. III p. 393.

Type 43b. White Pine Co. is northeast, and contains the White Pine Dist. The principal town is Hamilton about 110 miles south of Elko on the Cent. Pac.. The southern continuation of the Humboldt Range runs with some broken hills consisting chiefly of folded Devonian limestone. At Hamilton there arebent into a prominent anticline, ane this has a strong fissure crossing its axis.

The geological section is Devonian limestone , thin calcareous shale, thin silicious limestone, argillaceous shale probably Carboniferous, sandstone and Carboniferous limestone. (Hastings) .

The ore bodies occur according to Arnold Hague in four forms: All in the Devonian limestone. (1.) In fissures crossing the anticlinal axis. (2) In contact deposits between the limestone and

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Tucson as its principal city. There are numbers of mines of the
precious metals and a few less important copper deposits.
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rado River on quartz veins in metamorphic rocks, containing silver
and lead minerals.

Baxter G.T. 10th Census Vol XVIII p.64.
Blake W.P. The Geology of Tombstone Arizona M.E. 10. 356.
E.& M.J. June 24. 1882. p.388.
The Silver King Mine. Ashort Monograph. New Haven. March
1885 Rep. See also E.& M.J. April 25. 1885 p.288.
Blandy J.P. The Mining Region around Prescott Arzi. M.E. 11. 288.
E.& M.Jour. On Tombstone Arzi. May 7. 1881. p.316. Mar 19. 83.p/f
Silver in Arzi. General Review Eng.&M.J. 25. 1880 pp179.80
General Arizona Apr11 25. 1881. p.285.
Billingsley B. Reps. on the Mining Dists. of Arizona near the Rio Colo-
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Emmons S.F. Survey of the 40th Parallel Vol. XIX p. 303.

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folded Devonian limestone. At Hamilton these recede into a prom-
ment anticline, and this has a strong distance opposing its axis.

The geological position is Devonian limestone, thin calcareous
shale, thin siliceous limestone, crystalline shale probably Ore-
boniferous, sandstone and Carboniferous limestone. (Emmons)

The ore bodies occur according to Arnold Hague in four forms:
All in the Devonian limestone. (1) In fissures crossing the anti-
clinal axis. (2) In contact deposits between the limestone and

shales. (3) In beds or chambers in the limestone parallel to the stratification. (4) In irregular vertical and oblique seams or joints across the bedding. The ore is chiefly chloride of silver in quartz gangue. It is thought by Mr Hague to have probably come up through the main cross fissure and meeting the impervious shale to have spread through the limestone in this way.
Clayton J.E. Sections of the Rocks in Hamilton Nev. Cal. Acad Sci.
Hague.A. 40th Parallel Survey Vol. III.p.409.

Egan Canon is in the northern part of the county and shows a geological section of granite, quartzite and slate in the order named. In the slate and perhaps extending into the quartzite is a quartz vein 5'-8' wide carrying gold and silver ores.
Emmons S.F. 40th Parallel Survey Vol. III p. 445.

Eureka Co. is the next county west of White Pine. The deposits at Eureka have already been described under lead-silver Type 3

Type 43c. Lander Co. lies next west of Eureka. The Toyabe range runs through it from north to south and in its southern portion in Nye Co. contains the Belmont deposit (Type 43a). At Austin which is 80 or 90 miles south of the Cent. Pac. R.R. now connected with it by a branch, are the mines of the Reese River Dist. named from the principal stream near by. From Mt. Prometheus, which consists of biotite granite or granitite pierced by a great dike of rhyolite, a western granite spur runs out known as Lander Hill. The ore bodies are narrow fissure veins with a general northwest and south east trend, and carrying rich ruby silver ores, with gray copper, galena and blende, in a quartz gangue with associated rhodochrosite and calcite. They are also often faulted.
Emmons S.F. 40th Parallel Survey Vol. III p.349.

Elko Co. lies north of White Pine and Eureka Co,s and contains the Tuscarora Mining Dist.. The deposits are high grade silver ores in veins in a decomposed horn-blende andesite.
Becker G.F. 10th Census Vol. XIII. p. 34.

Humboldt Co. is the middle one of the northern tier, and contains a number of mining districts which produce both silver and gold from quartz veins in Mesozoic slate. Small amounts of the precious metals come also from Washoe Co. in the northwest corner of the State.
Becker G.F. 10th Census Vol. XIII. p. 35.

Churchill Co. adjoins Lander on the west, and posseses a few silver mines. Esmeralda Co. in the south west has a considerable number of rich silver and gold mines, which produce high grade ores from veins with a quartz gangue in metamorphic rocks, slates, schists etc.. See also under Nickel.

Storey and Lyon are two small counties in the western central portion of the State but the former contains the most important and interesting ore deposit in Nev. , if indeed it is not the largest and richest single vein yet discovered.

Type 44. Comstock Lode. A great fissure vein, four miles long

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Emmons S.F. 40th Parallel Survey Vol. III p. 446.

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Type 44. Comstock lode. A great fissure vein, four miles long

forked into two branches above, along a line of faulting in eruptive rocks of Tertiary age and chiefly andesites. In the central part of the vein the displacement has been about 3000' shading out however at the ends. The ores are high grade silver ores in quartz and occur in great bodies called bonanzas along the footwall. Over $300,000,000 in gold and silver have been extracted in the ratio of 2 of the former to 3 of the latter. Views regarding the geology of the Comstock have changed in the course of years, and as they have been influenced by the successive writings of v.Richthofen, King, Church, Becker and Hague and Iddings, the points in especial controversy being the determination of the rock species.

It may be remarked that the whole scheme of classification of our volcanic (effusive) rocks rests largely on v.Richthofen's early studies, and that perhaps the most important generalization of late years is due to the work of Hague and Iddings on the same. v.Richthofen (1865) showed that the ore body filled a fissure on the contact of a so-called syenite and an eruptive rock that he called porpylite. The ore and gangue are thought to have been brought up from below by solfataric action in which fluorine, chlorine and sulphur were the principal dissolving agents. Clarence King (1867-68 published 1870) brings out forcibly the fact that the foot wall of the vein approximates closely the natural continuation of Mt. Davidson and contends that the vein fills a fissure between the syenite of which Mt.Davidson consists and the late Tertiary eruptive rocks poured out against its flanks. He traced the geological succession of these and the filling of the vein from solfataric action attendant on a thin dike of andesite which forced its way into the contact fissure. J.A.Church (1877) imagines the diorite (called syenite above) of Mt Davidson to have been poured out originally in thin horizontal sheets, which were folded in east and west folds. This was to account for the bedding of the of the lode as now seen. On the diorite was poured out next the porpylite likewise in successive horizontal sheets. Then they were all tilted along a north and south axis and eruptions of andesite penetrated between their beds in very large amount. Further movements forced the convexities of the first formed folds against the andesite and crowded their substance sidewise to some extent into the synclinals. This movement slightly parted the beds, affording water courses through which rose siliceous waters. These dissolved away the neighboring beds, leaving extensive quartz bodies in their places. They also remeved the andesitic caps.

No ore was formed as yet. Now followed great trachyte eruptions on the east and loaded down the hanging wall of the lode so heavily as to cause a downward movement of it, on the foot, making a new series of openings, and into these poured the ore bearing solutions which brought the precious metals. No one who intelligently follows this explanation will doubt that Mr Church is a very ingenious man and yet few would be inclined to have very much confidence in

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this long unnatural hypothesis when a simpler course will lead to the same results. At the time of Mr Churchs visit the workings were becoming very deep, and the great heat was manifesting itself which has been since such an obstacle. Flooded drifts it was thought had been noticed to grow hotter and from this the remarkable hypothesis of kaolinization was conceived. It was that the kaolinization of the feldspar in the deeply buried rock occasioned the heat of the lode. G.F.Becker (1879-82) comments on the excessive alteration which the rocks have undergone, as it figures largely in his hypothesis of origin. He then traces the results of faulting and shows that under conditions like those present the surface would tend to assume a logarithmic curve, which coincides surprisingly well with the present outline of the country. After describing the lode itself, the origin of its metalliferous contents is traced as follows. Waters under hydrostatic pressure from the hights to the west are supposed to have percolated toward the lode passing through deeply buried regions of heat. They were probably diverted from rising directly through the lode by an impervious clay seam, and were thus forced to soak through the diabase hanging relieving it in passage of the metals which were afterwards deposited in the higher portions of the lode. The metals themselves were probably largely derived from the augite of the rock.

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Hague and Iddings after demonstrating that the forms assumed by the various rocks depended largely on the depths at which they solidified, concluded that "the Comstock Lode occupies a line of faulting in rock of Tertiary age, and can not be considered as a contact vein between two different rock masses".

Becker G.F. Geology of the Comstock Lode and the Washoe Dist. Monograph III.U.S.G.S. Rec. See also E.& M.J. Mar. 1. 1884 p. 162 and 2nd Ann. Rep. Director U.S.G.S. Rec.

Church J.A. The Comstock Lode, its Formation and History. N.Y. John Wiley & Sons. Reviewed E.& M.J. Feb.21 1880 p.397. See also shorter paper in the E.& M.J. July 19. 79 p. 35 Dec.28 '78 p.456. E.& M.J. Jan. 23. 1886 p.52 Dec 12. 1885 p.397.

Eng. & Min. Jour. On the Changes in the Comstock vein Dec. 18. 1886. p. 434.

Hague & Iddings On the Development of crystallization in the Igneous Rocks of Washoe Nev. etc. Bull. 17. U.S.G.S. See also Bull. 6.Cal.Acad. Sci. and E.& M.J.Dec.11.86.p.415.

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John Wiley & Sons. Reviewed E.& M.J. Feb.21 1880 p.297.

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Dec.29 78 p.456. E.& M.J. Jan. 25. 1879 p.83

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King Cl. 40th Parallel Survey Vol. III. pp 9.
v. Richthofen F. Report for the Sutro Tunnel Co. 1865.
The Natural System of Volcanic Rocks Cal. Acad. Sci. 1867. also Zeitsch. d. d. Geol. Ges. 1868. 663. Abstract A.J.S. II. 45. 267.
Raymonds Report and the Reports of the Mint have numerous other short and less important papers.
Note. The Steamboat Springs in the same region as the Comstock are mentioned under Mercury.

THE REGION OF THE PACIFIC SLOPE.

Type 45. Oregon and Washington. Geography and geology explained at length. An increasing amount of gold and silver is being obtained in Washington, the former chiefly from placer mines in Yakima, Stevens and Kittitas Co,s which are largely worked by Chinese. Considerable silver is also obtained in Stevens Co. in the northeastern corner of the state. In Oregon, Baker Co. in the eastern portion produces the most and here there seems to be a northerly development of the Cal. gold belt affording both placers and gold quartz, in slates and granite. Next is Grant Co. with placers and Josephine Co. with the same. While a number of others produce less amounts. In Curry Co. is found-

Type 45a. Port Orford. Auriferous beach sands at the foot of gravel cliffs and shifting with the winds and tides. (Compare under Magnetite Type 15, amd in the Black Hills Type 38 the Potsdam shore deposits). They can only be reached at low tide. They extend along the coast near the junction of Oregon and Cal. in both states.
Becker G.F. 10th Census Vol. XIII. 27.
Blakd W.P. A.J.S. II. 18. 156.
Chase A.W. The Auriferous Gravels Deposit of Gold Bluffs Cal.. Cal. Acad. Sci. 1874. A.J.S. III. 7. 367.
E.& M.J. Dredging for Gold June 23. 1883. p. 369
Silliman B. A.J.S. III. 6. 132.

California. Geography and geology explained at length. Historical mention of its settlement and the gold excitement of 49 California's principal metal product is gold, but quite recently an important silver district has been developed. For copper see Type 16a, for iron see Type 14(2), for mercury see Type 55, for chromite see Type 53.

Type 46. Calico Dist.. Deposits of silver shloride in fissur veins, small fractures and pockets in liparites and tufaceous sandstones probably of the Pliocene Series. They occur in south wester Cal. in a portion of the state belonging rather to the Great Basin than the Pacific Slope. An immense outbreak of liparites has forme a series of elevations and the attendant tufas are extensively developed. The ore is thought by Lindgren to have come in heated

King Cl. 40th Parallel Survey Vol. III. pp 9.
v.Richthofen F. Report for the Sutro Tunnel Co. 1865.
The Natural System of Volcanic Rocks Cal. Acad. Sci.
1857. also Zeitschr.d.Geol. Ges. 1868. 655. Abstract
A.J.S. II. 45. 267.
Raymonds Report and the Reports of the Mint have numerous other
short and less important papers.
Note. The Steamboat Springs in the same region as the Comstock
are mentioned under Mercury.

THE REGION OF THE PACIFIC SLOPE.

Type 45. Oregon and Washington. Geography and geology explained at length. An increasing amount of gold and silver is being obtained in Washington, the former chiefly from placer mines in Yakima, Stevens and Kittitas Co.s which are largely worked by Chinese. Considerable silver is also obtained in Stevens Co. in the northeastern corner of the state. In Oregon, Baker Co. in the eastern portion produces the most and here there seems to be a northerly development of the Cal. gold belt affording both placers and gold quartz, in slates and granite. Next is Grant Co. with placers and Josephine Co. with the same. While a number of others produce less amounts. In Curry Co. is found-

Type 45a. Port Orford. Auriferous beach sands at the foot of gravel cliffs and shifting with the winds and tides. (Compare under Magnetite Type 15, and in the Black Hills Type 38 the Potsdam shore deposits). They can only be reached at low tide. They extend along the coast near the junction of Oregon and Cal. in both states.
Becker G.F. 10th Census Vol. XIII. 27.
Black W.P. A.J.S. II. 18. 156.
Chase A.W. The Auriferous Gravel Deposit of Gold Bluffs Cal.. Cal. Acad. Sci. 1874. A.J.S. III. 7. 327.
E.& M.J. Dredging for Gold June 23. 1883. p. 383
Silliman B. A.J.S. III. 6. 152.
California. Geography and geology explained at length. Historical mention of its settlement and the gold excitement of 48. California's principal metal product is gold, but quite recently an important silver district has been developed. For copper see Type 18a, for iron see Type 14(3), for mercury see Type 55, for chromite see Type 53.

Type 46. Calico Dist.. Deposits of silver chloride in fissure veins, small fractures and pockets in fissurites and tufaceous sandstones probably of the Pliocene Series. They occur in south western Cal. In a portion of the state belonging rather to the Great Basin than the Pacific Slope. An immense outbreak of fissurites has formed a series of elevations and the attendant veins are extensively developed. The ore is thought by Lindgren to have come in heated

solution from below and to have filled the fissures and over-flowed forming the surface deposits in the tufas. (Compare Silver Cliff Col. Type 37d).

Lindgren W. The Silver Mines of Calico Cal. M.E. 15. 717.

Type 47. Auriferous Gravels. (1) River Gravels or Placers in auriferous gravels in the beds of running streams. These have been often referred to in other states but the type is placed in Cal. as they are there best known. They were the first gravels washed in '49 and although substantially exhausted by 1860 were very productive (Outline of the topography of the western slope of the Sierras. A quite gentle rise over Mesozoic slates with quartz veins and high gravels). The present streams have cut deep canons and in their bottoms concentrated much of the heavier material of the higher gravels and the neighboring slates. Such concentrations were called bars and the streams were sluiced around them in order to reach the gravel. (2) High Gravels (or Deep Gravels). Lying above the present river bottoms are found great bodies of gravels belonging to a former and now extinct system of drainage, doubtless referable to the Pleiocene epoch. These gravels extend for 250 miles along the Sierras and up to 5000' above the sea. They reach a very considerable thickness and often detrital material to a thickness of 100' or more is removed by the hydraulic process. They must have been accumulated during a period of much greater rainfall than now.

After the deposit of the gravels great outbreaks of eruptive rocks occured, covering a great part of them with a cap of basalt. They are sometimes mined out from under this cap by tunnels. The fine cementing material in the lower portions of the gravels is often colored blue (from FeO) giving origin to the term "blue lead" while the upper portion is oxidized red (from Fe_2O_3).

Many trunks of trees silicified or replaced by pyrite or only lignitized occur in the gravels, also some bones etc. (Note the Calaveras skull) and leaf impressions in the clays. Mention of other hypotheses of origin for the gravels now generally rejected; from one great river; of marine origin; from glaciers. Mention of chemical theories to account for the formation of nuggets.

Becker G.F. Notes on the Stratigraphy of Cal. Bull. 19. U.S.G.S.

Blake W.P. The Various Forms in which Gold occurs in Nature. Rept. of Director of the Mint. 1884. p. 573.

Egleston T. Formation of Gold Nuggets and Placer Deposits. M.E. 9.63
Working Placer Dep. in the U.S. S of M.Q. VII. 101.

Hammond J.H. Auriferous Gravels of Cal. Rept. of Director of Mint 1881. p. 616. rec.

Hanks H.G. Placer Gold. Rept. of Director of Mint 1882. p.728.

Hanks H.G.& Irelan W'm. Rept. of the Cal. State Mineralogist Ann.

Hunt T.S. On a recent Formation of Quartz and on Silicification in Cal. E.& M.J. May 29. 1880. 369.

Leconte J. The Old River Beds of Cal. A.J.S.III. 19. 1880. p.176.

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Becker G.F. Notes on the Stratigraphy of Cal. Bull. 19. U.S.G.S.
Blake W.P. The Various Forms in which Gold occurs in Nature. Rept
of Director of the Mint. 1884. p. 572.
Egleston T. Formation of Gold Nuggets and Placer Deposits. M.E.9.
Working Placer Dep. in the U.S. S of M.Q. VII. 101.
Hammond J.H. Auriferous Gravels of Cal. Rept. of Director of Mint
1881. p. 816. rec.
Hanks H.G. Placer Gold. Rept. of Director of Mint 1882. p.728.
Hanks H.G. & Ireland W m. Rept. of the Cal. State Mineralogist Ann.
Hunt T.S. On a recent Formation of Quartz and on Silicification i
Cal. E.& M.J. May 29. 1880. 369.
Leconte J. The Old River Beds of Cal. A.J.S. III. 19. 1880. p.176.

McGillivray J.J. The Old River Beds of the Sierra Nev. of Cal. Rept. of the Dir. of Mint. 1881. p.630.
Murchinson R.I. Siluria etc. Sketch of the Distrib. of Gold over the Earth.
Newberry J.S. On the Genesis and Distrib. of Gold. S. of M. Quarterly Vol.III. p.6. E.& M.J. Dec. 24.& 31. 1881 Rec.
Phillips J.A. Notes on the Chem. Geol. of the Cal. Gold Fields. phil Mag. Vol. XXXVI. p.32L/ Proc. Royal Soc. XVI. 294. A.J.S. II.47. 134.
Silliman B. On the Deep Placers of the South & Middle Yuba Nev. Co. Cal. A.J.S. II..40.
Whitney J.D. Auriferous Gravels of the Sierras. Cambridge 1880. Climatic Changes in later Geological Times. Cambridge.
See also General works cited on p. 47.

Type 48. Gold quartz veins. Beds or veins of quartz (usually described as segregated veins) in slates and metamorphic schists parallel to the bedding (quite analogous in shape to the magnetite beds (Type 13) and the pyrite do.(Type 16)) and carrying free gold, auriferous pyrites and other sulphides. Frequent mention has been made of deposits of this character in connection with ore bodies of a different character. Those in Cal. which is the most productive state , are in the Mesozoic(chiefly Jurassic) slates already referred to under Type 47. The largest is the so-called Mother Lode, which extends 80 miles with a few breaks. It is probably a silicified of replaced dolomite (Whitney) as it often contains more or less magnesian rock. The other quartz veins are of far less extent but furnish very great amounts of gold quartz. They split off at times into the slates, and are themselves divided by thin faultings of slaty material. These are thought by J.D. Whitney to have all been formed during the metamorphism of the slates which was probably attendant on the elevation of the Sierras about the close of the Jurassic. Various beds of rocks that are regarded by Wadsworth as altered volcanic tuffa occur with the slates, so that Jurassic volcanic action may have been a factor. Certain it is that a very extensive circulation of silicious solutions was in progress, and this probably concentrated the gold in the veins. G.F.Becker (l.c.) thinks that the same disturbance which determined the existence of the Coast Range added the gold-belt proper to the Sierra Nevada.

Becker G.F. The Quicksilver Deposits of the Pacific Slope p. 460.
Blake W.P. Remks. on the Extent of the Gold Region of Cal. etc. A.J.S. II. 20. 72.
Bowman.A. Geology of the Sierra Nevada in Relation to Vein Mining. Raymonds Reports. 1875. p. 441.
Corning F.G. The Gold Quartz Mines of Grass Valley Cal. E.& M.J. Dec. 11. 1886. p. 418.
E.& M.J. Mines & Mining in Cal. Sep. 12. 1885. p. 184.

McGillivray J.J. The Old River Beds of the Sierra Nev. of Cal.
Rept. of the Dir. of Mint. 1881. p.650.
Murchinson K.I. Siluria etc. Skeleton of the Distrib. of Gold over the Earth.
Newberry J.S. On the Genesis and Distrib. of Gold. S.of M.Quarterly Vol.III. p.6. R.& M.J. Dec. 24.& 31. 1881 Nos.
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Silliman B. On the Deep Placers of the South & Middle Yuba Riv. Co. Cal. A.J.S. II..40.
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Becker G.F. The Quicksilver Deposits of the Pacific Slope p. 480.
Blake W.P. Remks.on the Extent of the Gold Region of Cal. etc. A.J.S. II. 20. 78.
Bowman.A. Geology of the Sierra Nevada in Relation to Vein Mining. Raymonds Reports. 1875. p. 441.
Gorring P.G. The Gold Quartz Mines of Grass Valley Cal. R.& M.J. Dec. 11. 1880; p. 418.
R.& M.J. Mines & Mining in Cal. Sep. 12. 1885. p. 184.

Newberry J. On the Genesis and Distrib. of Gold.S.of M.Q. III.p.16
Remond A.Mining Statistics No 1. Cal.Geol. Survey,On Gold Quartz Mines.
Phillips J.A. Ore Deposits. p. 524. Rec.
Whitney J.D. & others in the Repts of the Geol. Survey of Cal.

Type 49.Southern States. 1..Gold quartz veins (segregated veins) in metamorphic slates, talcose schists etc. of late Archaean or early Palaeozoic age, with associated granite and syhite rocks and trap dikes. (2) Bands of auriferous slates with pyrite. The belt of auriferous metamorphic slates really begins in Md. although gold is known in the states further north. It runs in varying width into Ga. reaching its maximum of 70 miles in N.C. and being 15 miles in Va.. Lieber the early state geologist of S.C. in the paper cited below from the Gangstudien, divided the auriferous deposits into I. Schists. II. Veins (a) endogenous (b) deparital, (c) exogenous, a classification of small value, and mentions also an auriferous limestone that was mined. Kerr (M.E. 10. 470) reports the gold in a great variety of associations so that it seems very generally distributed through these metamorphic rocks. Genth mentions it in a diorite dike.

Placer deposits are also quite wide spread and were first worked They however never attained great development.

Historical Views and sections.

Blake W.P. ,Eaton A.,Olmstead D.,Shepherd C.U. and the older Silliman and others have many references to gold in the southern states in the early numbers of the Am. Jour. of Sci.
Devereux W.B. Gold and its associated minerals at Kings Mtn. N.C. E.& M.Jour. Jan. 15. 1881. p. 39.
E.& M.Jour. Auriferous Slate Deposits of the Southern Mining Region June 11. 1881. p. 397.
Genth F.A. Contributions to Mineralogy A.J.S. II. 28. 246.
Hand F.C. Southern Gold Fields. E.& M.J. Dec.7. 1889. p. 495.
Hanna G.B.The Fineness of native Gold in the Carolinas and Ga. E.& M.Jour. Sep. 18. 1886. p. 201.
Kerr W.C. Gold Gravels of N.C. M.E. 8. 462.
Some Peculiarites in the occurrence of Gold in N.C. M.E. 10. 475.
Lieber O.M. Ueber das Gold-vorkammen in N.C. Gangstudien. Vol.3. p.253. Lieber states that Whitneys Metallic Wealth was written to "boom" certain Mines !!!!.
" " Gold in S.C. In Gangstudien Vol. III. 253. 481.
Mell.P.H. Auriferous Slate Deposits in Southern Mining Regions M.E. 9. 399.
Spillsbury E.G. Gold Mining in S.C. M.E. 12.99. E.& M.J.June 23. 1883. p. 362.

Appendix to Type 49. Type 49a. Ishpeming Mich. Gold quartz veins in the metamorphic rocks of the iron bearing Huronian System.

Newberry J., On the Gonesis and Distrib. of Gold.S.of M.J. XII,p.16
Hammond A.Mining Statistics No 1. Cal.Quart. Survey,On Gold Quartz
Mines.
Phillips J.A. Ore Deposits. p. 554. Nos.
Whitney J.D. & others in the Reports of the Geol. Survey of Cal.

Type 49.Southern States. I..Gold quartz veins (unmetamorphosed veins) in metamorphic slates, talcose schists etc. of late Archaean or early Palaeozoic age, with associated arsenite and pyrrhite rocks and trap dikes. (B) Bands of auriferous slates with pyrite. The belt of auriferous metamorphic slates really begins in Md. although gold is known in the states further north. It runs in varying width into Va. reaching its maximum of 70 miles in N.C. and being 12 miles in Va.. Likebon the early state: geologist of S.C. in the paper cited below from the Computation, divided the auriferous deposits into I, Schists. II. Veins (a) endogenous (b) deposits, (a) exogenous, a classification of small value, and mentions also an auriferous limestone that was mined. Kerr (M.J. 19. 479) reports the gold in a great variety of associations so that it occurs very generally distributed through these metamorphic rocks, Genth mentions it in a diorite dike.

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Thompson W.B. Gold and its associated minerals as Ellega Min. N.C. E.& M.Jour. Jan. 15, 1881. p. 39.

E.& M.Jour. Auriferous Slate Deposits of the Southern Mining Region June 11. 1881.. p. 397.

Genth F.A. Contribution to Mineralogy A.J.S. II. 38. 246.

Hunt T.S. Southern Gold Fields. E.& M.J. Dec.7. 1889. p. 699.

Adams G.F.The Pineness of Native Gold in the Carolinas and Ga. E.& M.Jour. Sep. 18. 1886. p. 201.

Kerr W.C. Gold Gravels of N.C. M.R. 8. 662.

Some Peculiarities in the occurrence of Gold in N.C. M.R. 10. 672.

Kloose O.M. Ueber das Gold-vorkommen in N.C. Computation. Vol.1v. p.283. Kloose states that Whitneys Metallic Wealth was written to "boom" certain Mines !!!!.

" Gold in S.C. In Computation Vol. IXX, 383. 481.

Mall.F.M. Auriferous Slate Deposits in Southern Mining Regions M.R. 9. 399.

Spillsbury E.G. Gold Mining in N.C. M.R. 18.92. E.& M.J.June 28. 1883. p. 382.

Appendix to Type 49. Type 49a. Lamprophyre Veins. Gold quartz veins in the metamorphic rocks of the iron bearing Huronian System.

Recent developments especially at the Ropes mine have shown that gold quartz veins exist in paying quantity in the same region as the specular hematite mines of the Marquette district. (See Type 9a).

E.& M.Jour. The New Mich. Gold Finds. Sep. 22.'88. p. 238.
Lawton C.D. Ann.Rep. of the Mich. Com. of Mineral Statistics '87 p137

Alaska. Geography and geology outlined as far as possible. The territory produces nearly a half million dollars in gold annually from placer workings on the Yukon River and from mines on the Aleutian Islands.

Type 50. Douglass Is. A dike ? or boss ?of granite 400' wide piercing alates regarded as Triassic by G.M.Dawson. and impregnated (i.e. the granite) with auriferous pyrites. This enigmatical ore body is thought by Dawson to be the upper part of a granite dike. It consists in great part of a mass of quartz, feldspar, calcite and pyrite in which are buried the so-called kernels which have been shown by F.D.Adams to be masses of less altered granite, almost without the pyrite. Both varieties show abundant cataclastic or crushed structure, as evidence of having suffered from dynamic movements. Adams concludes that the mass was originally a hornblende granite ,and Dawson that it has altered by solfataric circulations which brought in the gold. The gold itself is in irregular masses in the pyrite. The Treadwell Mine located here is very extensive and the chief source of the Alaska bullion.

Adams F.D. On the Microscopical character of the Ore of the Treadwell Mine. Alaska. Amer. Geol. Aug. 1889. p. 88.
Dawson G.M. Notes on the Ore Deposit of the Treadwell Mine Alaska. Amer. Geologyst August 1889. p. 84.

SILVER. PRODUCTION IN 1000 DOLLARS.

	1850	1860	1870	1880	1885	1887
Arizona				2325	3800	3800
California				1150	2568	1500
Colorado				16549	15800	15000
Dakota						40
Idaho				464	3500	3000
Montana				2905	10060	15500
Nevada				12430	6000	4900
New Mexico				392	3000	2300
Other States				120	190	393
Mexico				25167	32111	37570
Central America				[illegible]0	350	350
South America				17500	25984	21640
Australia			4691200	227	1048	266
Germany				5576	5915	995?
Austria				1994	2090	2219
Other Countries				4879	5656	9523
Total United States	50	1[illegible]0	16000	39200	51600	53433
Total Foreign				55351	66845	72219

Recent developments especially at the Popes mine have shown that gold quartz veins exist in paying quantity in the same region as the specular hematite mines of the Marquette district. (See Type 9a).

E.& M.Jour. The New Mich. Gold Mines. Sep. 22, p. 228.
Iowan G.S. Ann.Rep. of the Mich. Com. of Mineral Statistics 1912.

Alaska. Geography and geology outlined as far as possible. The territory produces nearly a half million dollars in gold annually from placer workings on the Yukon River and from mines on the Aleutian Islands.

Type 80. Douglass Is. A dike ? or boss ? of granite 600' wide planerite dikes regarded as Triassic by G.M.Dawson, and impregnated (i.e. the granite) with auriferous pyrites. This auriferous ore body is thought by Dawson to be the upper part of a granite dike. It consists in great part of a mass of quartz, feldspar, calcite and pyrite in which are buried the as-called kernels which have been shown by R.T.Adams to be masses of less altered granite. Almost without the pyrite. Both varieties show abundant cataclastic or crushed structure. As evidence of having suffered from dynamic movements. Adams concludes that the mass was originally a porphyritic granite, and Dawson that it has altered by pneumatolytic solutions which brought in the gold. The gold itself is in irregular masses in the pyrite. The Treadwell mine located here is very extensive and the chief source of the Alaska bullion.

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Dawson G.M. Notes on the Ore Deposit of the Treadwell Mine Alaska. Amer. Geologist August 1899. p. 84.

SILVER. PRODUCTION IN 1909 BY STATES.

	1909	1908	1907	1906	1905
Arizona					
California					
Colorado					
Idaho					
Montana					
Nevada					
New Mexico					
Other States					
Mexico					
Central America					
South America					
Australia					
Germany					
Austria					
Other Countries					
Total United States	57				
Total Foreign					

In 1887 the States ranked: 1,Mont. 2.Col., 3.Utah. 4.Nev., 5,Ariz. 6.Id. 7.N.M. 8.Cal. 9.Tex. 10.Wash. etc.. In 1888 the total production of silver in the U.S. is estimated at $59.195.000. and of the rest of the world $83.242.150. These figures are taken chiefly from the Mineral Resources of the U.S. ,the Annual Report of the Director of the Mint and from the E.& M.Jour. Jan. 4 1890. There is some discrepancy in the totals on account of different authorities.

GOLD.PRODUCTION IN 1000 DOLLARS.

	1850	1860	1870	1880	1885	1887
Alaska				6	300	675
Arizona				211	880	830
California				17151	12700	13400
Colorado				2699	4200	4000
Dakota				3305	3200	24000
Georgia				31	136	110
Idaho				1479	1800	1900
Michigan						35
Montana				1805	3300	5230
Nevada				4888	3100	2500
New Mexico				49	800	500
North Carolina				118	152	225
Oregon				1097	800	900
South Carolina				13	43	50
Utah				291	180	220
Washington				135	120	150
Ala. Tenn. Va. etc.				43	90	22
Central America				2274		150
South America				5171	9963	10140
Europe				29956	27604	23028
Africa				1993	2643	1919
Australia		24030$	19230$	28765	27439	27327
Total U.S.	50000	46000	50000	33378	31801	33147
Total Foriegn				70436		73954

In 1887 the States ranked 1.Cal. 2.Mont. 3.Col. 4.Nev. 5.Dak. 6.Id. 7.Oreg. 8.Ariz. 9.Alaska. 10.N.M. 11.N.C. etc.. The total production of gold in the U.S. in 1888 is estimated at $33.175.000 and of the rest of the world $72.819.150. On the totals of gold and silver in 1887 the states ranked 1.Mont. 2.Col. 3.Cal. 4.Nev. 5.Utah. 6.Id. 7.Ariz. 8.N.M. 9.Dak. 10.Oreg. 11.Alaska etc.. These figures are taken from the Reports of the Director of the Mint, and the Mineral Resources.

Remarks on Australia and the Urals as gold producers.

5.Ariz. 6.Id. 7.N.M. 8.Cal. 9.Tex. 10.Wash. etc.. In 1888 the tot
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Dakota				3305	3200	3400
Georgia				31	156	110
Idaho				1479	1800	1900
Michigan						35
Montana				1805	3300	3230
Nevada				4883	3100	2500
New Mexico				49	800	500
North Carolina				113	152	225
Oregon				1097	800	900
South Carolina				13	43	30
Utah				391	180	220
Washington				133	120	150
Ala. Tenn. Va. etc.				43	90	22
Central America				2274		150
South America				8171	9965	10440
Europe				29956	37604	23028
Africa				1993	2643	1919
Australia			2103803	192303	29785	27437	27327
Total U.S.		50000	46000	50000	33378	31801	33147
Total Foreign					7043E		72954

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ver in 1887 the states ranked 1.Mont. 2.Col. 3.Cal. 4.Nev. 5.Utah
6.Id. 7.Ariz. 8.N.M. 9.Dak. 10.Oreg. 11.Alaska etc.. These figure
are taken from the Reports of the Director of the Mint, and the
Mineral Resources.

Remarks on Australia and the Urals as gold producers.

THE LESSER METALS.

The lesser metals will be treated in alphabetical order. Types will be made of important and well known deposits.

Aluminium.

This metal is of growing importance especially in its alloys. It is obtained from corrundum (Al_2O_3) (see under Abrasives), from alum, and from cryolite large quantities of which are imported to Philadelphia from Greenland. As so much of the aluminium goes into alloys no statistics are available.

ANTIMONY.

Stibnite Sb_2S_3 Sb.71.8. S.28.2. Antimony is chiefly valuable for a few alloys into which it enters. It is necessarily produced in small amount as any great quantity would break the market. It sometimes occurs in composition with silver in the ruby ores etc.

Type 51. Kern Co. Cal. In San Emigdio Southern Cal. is the only deposit of commercial importance. Here is a large vein in granite with quartz gangue, varying from a few inches to several feet. Its capabilities are thought good. Several other deposits are worked in a small way in San Benito Co. and a number of others localities are recorded by Hanks. (l.c.).

Type 51a. Sevier Co. Ark.. Stibnite occurs in veins with quartz gangue in sandstone. Some antimony ochers are found in the upper portions.

Type 51b. Humboldt Co. Nev. Stibnite occurs in several places in Humboldt Co. Nev. in veins with a quartz gangue.

Type 52. Iron Co. Utah. In southwestern Utah some remarkable deposits of stibnite are known, occurring as masses of the radiating needles following the stratification of sandstones, and between the boulders of an associated conglomerate. Peices weighing several tons have been obtained? According to Blake it must have crystallized probably from descending solutions in the sandstone after the formation of the latter. Eruptive rocks are present above the sandstone. Attempts have been made to work the ore, always resulting in failure. Considerable antimony has been produced in New Brunswick from near Fredericton and also from Nova Scotia. An interesting deposit of Sepiarmontite was worked for a time in Sonora Mex. just south of Arizona. 75 short tons were produced in Cal. in 1887.

Bailey L.W. Discovery of Ant. in N.B..A.J.S.II. 35. 150.
Blake W.P. General Distrib. of Antimony .Min.Res. 1883-84 P.641-Rec.
Douglass J. The Antimony Deposit of Sonora. E.& M.J. May 21.81.p350.
Dunnington F.P. The Minerals of a Deposit of Antimony Ores in Sevier Co. Ark. A.A.A.S. 1877. Rec.
Hanks H.G. Rept Cal. State Mineralogist 1884.
Kunz G.F. Native Antimony etc. from Prince William, York Co. N.B. A.J.S. III.30. 275. The paper gives the references.
Newberry J.S. The Ant. Mines of S.Utah.Proc. Nat'l Acad. 1880

THE LESSER METALS.

The lesser metals will be treated in alphabetical order. Types will be made of important and well known deposits.

Aluminium.

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ANTIMONY.

Stibnite Sb_2S_3 Sb.71.8. S.28.2. Antimony is chiefly valuable for a few alloys into which it enters. It is necessarily produced in small amounts as any great quantity would break the market. It sometimes occurs in composition with silver in the ruby ores etc.

Type 81. Kern Co. Cal. In San Emigdio Southern Cal. is the only deposit of commercial importance. Here is a large vein in granite with quartz gangue, varying from a few inches to several feet. Its capabilities are thought good. Several other deposits are worked in a small way in San Benito Co. and a number of others localities are recorded by Banks. (l.c.4.

Type 81a. Sevier Co. Ark.. Stibnite occurs in veins with quartz gangue in sandstone. Some antimony ochres are found in the upper portions.

Type 81b. Humboldt Co. Nev. Stibnite occurs in several places in Humboldt Co. Nev. in veins with a quartz gangue.

Type 82. Iron Co. Utah. In southwestern Utah some remarkable deposits of stibnite are known, occurring as masses of the radiating needles following the stratification of sandstones, and between the boulders of an associated conglomerate . Pieces weighing several tons have been obtained. According to Banks it must have crystallized probably from descending solutions in the sandstone after the formation of the latter. Eruptive rocks are present above the sandstone. Attempts have been made to work the ore, always resulting in failure. Considerable antimony has been produced in New Brunswick from near Fredericton and also from Nova Scotia. An interesting deposit of Stibnite was worked for a time in Sonora Mex. just south of Arizona. 75 short tons were produced in Cal. in 1887.

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Hanks H.G. Rept Cal. State Mineralogist 1884.

Kunz G.F. Native Antimony etc. from Prince Williams,York Co. N.B. A.J.S. III.39. 278. The paper gives the references.

Penhallow D.P. The Ant. Mines of S.Utah.Proc. Nat'l Acad. 1890

Wait C.E. Antimony Deposits of Ark. M.E. 8. 42.
Williams C.P. Notes on the Occurrence of Antimony in Ark. M.E.3.150
Geological Survey of Arkansas, Vol I pp

ARSENIC.

Although arsenic is not produced in this country commercially it is very common in the silver ores of the west. It is produced in the form of the oxide from the Del Oro Mines Ontario, from auriferous mispickel.
Mineral Resources. 1883-84. p. 656.

BISMUTH.

Bismuth is known in various Col. mines in the San Juan Dist. (See Type 37). Some small amounts have been experimentally extracted. Lane's Mine at Monroe Conn. is an interesting locality for native bismuth in quartz.
Mineral Resources. U.S. 1885. p. 389.

CHROMIUM.

Chromite ($FeO.Cr_2O_3.Fe_2O_3$). Cr_2O_3 68. Although chromium is is not used in the metallic state, it is an important chemical reagent and pigment and gives a great hardness to steel. The mineral chromite is its universal source. This is found in connection with those serpentine rocks, which are probably altered peridotites and in general with rocks rich in magnesia. Extensive developments of serpentine occur near N.Y. City, with disseminated chromite (New Rochelle). The presence of chromium in Staten Island limonite Type 1a. has already been mentioned.

Type 53. Chromite in Serpentine. In Southeastern Penn. and the adjacent parts of Md. the serpentines are very extensive and have afforded considerable chromite in the past, making Baltimore the center of its manufacture. The chromite occured in masses interbedded in the serpentine. Other deposits are reported from N.C. But the present almost exclusive producer is Cal. and several thousand tons are annually obtained from Del Norte, San Luis Obispo Placer and other counties. It is very generally distributed in the Cal. serpentines . Traces of nickel minerals almost always also seen. 3000 long tons of chromite were produced in Cal. in 1887.
Chester F.D. Ann. Rept. Penn. Survey 1887. pp. 93, 105.
Day D.T. Mineral Resources U.S. 1882 p.428. 1883-84 p. 567. Rec. 1885. p. 357. 1886. p. 176. 1887. p. 132.
Farser P. The Northern Serpentine Belt in Chester Co. Pa.M .E.12.34?
Williams G.H. The Gabbros and associated hornblende rocks near Balto. Bull. 28. U.S.G.S. pp. 50-59.

COBALT.

(See under NICKEL).

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Bismuth is known in various Col. mines in the San Juan Dist. (See Type 37). Some small amounts have been experimentally extracted. Lame's Mine at Monroe Conn. is an interesting locality for native bismuth in quartz.
Mineral Resources. U.S. 1885. p. 389.

CHROMIUM.

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Type 33. Chromite in Serpentine. In Southeastern Penn. and the adjacent parts of Md. the serpentines are very extensive and have afforded considerable chromite in the past, making Baltimore the center of its manufacture. The chromite occurred in masses interbedded in the serpentine. Other deposits are reported from N.C. But the present almost exclusive producer is Cal. and several thousand tons are annually obtained from Del Norte, San Luis Obispo Placer and other counties. It is very generally distributed in the Cal. serpentines . Traces of nickel minerals almost always also seem. 3000 long tons of chromite were produced in Cal. in 1887.
Chester P.D. Amm. Rept. Penn. Survey 1887. pp. 93, 105.
Day D.T. Mineral Resources U.S. 1882 p.428. 1883-84 p. 567. Rec. 1885. p. 357. 1886. p. 176. 1887. p. 132.
Peyser P. The Northern Serpentine Belt in Chester Co. Pa.M .E.12.342
Williams G.H. The Gabbros and associated hornblende rocks near Balto. Bull. 28. U.S.G.S. pp. 50-59.

COBALT.

(See under NICKEL).

MANGANESE.

Pyrolusite MnO_2 Mn 63.2
Braunite Mn_2O_3

There are also psilomelane and various hydroxides and earthy deposits. Franklinite mentioned; see under zinc. Type 28. Manganese ores generally occur in much the same way as limonite and often associated with it. The ores are known in almost every state but are worked in but few. About 45% metallic Mn should at least be present and for spiegeleisen there should be but little phosphorus. The deposits of the New England states especially in Vt. and Mass. deserve mention, the ore being in much the same association as the limonites. Type 2a. The ores from the franklinite deposit (Type 28) after being deprived of their zinc are smelted for spiegel.

Type 54. Crimora Va. In Virginia the most productive mines are found. The largest are the Crimora Mines in Augusta Co.. They occur in elliptical basin , hollowed out of Potsdam sandstone, and filled with beds of sand and clay. Nodules of concretionary psilomelane are found scattered through the clay. The original source of the ore is doubtless the lower members of the Middle Cambrian (Auroral) consisting of ferriferous shales. Lime was probably the precipitating agent. In northwestern Ga. near the town of Cartersville are the next most productive mines. Here likewise the ore occurs in superficial deposits of sands and ochreous dirt, resting on the Potsdam. Both pyrolusite and psilomelane are found.

Type 54a. Batesville Ark. Recent developments have brought to light extensive deposits of manganese ores in two districts in Ark. The first centers around Batesville in the northern central part of the state. The ore is in two forms of deposit, first as boulders like those already mentioned above, distributed through diluvial clay etc. resting on Subcarboniferous limestone. The ore was probably derived from veins originally in the limestone and set free by its weathering. The second class of deposits consists of nodules of manganese ore buried in a red matrix of silicious iron ore that underlies the Subcarboniferous limestone referred to above. The second manganese area is in southwestern Ark. and contains both true veins and pockets. Forthcoming publications of the Ark. Geol. Survey will probably fully describe these as well as the Batesville district. The presence of manganese in the Gogebic hematites has already been referred to (Type 9c) also at Butte Mont. (Type 17. p. 28). Mention should also be made of Red Rock, San Francisco Harbor, and of the New Brunswick and Neve Scotia Mines. 34524 long tons of manganese ore were produced in 1887.

Day D.F. Mineral Res. 1882. p.424. 1883-84 p. 550.
E.& M.J. Cremora Manganese Mines. Va. Mar. 22. 1890.
Hoy H. Ores of Manganese and their use Proc. Nova Scotia Inst. Nat. Sci. 1864. p. 139
Weeks J.D. Mineral Resources 1885. p.303. Rec 1886.p.180.1887 p.144

MANGANESE.

Pyrolusite MnO_2 63.2
Braunite Mn_2O_3

There are also psilomelane and various hydroxides and earthy deposits. Franklinite mentioned; see under zinc. Type 28.

Manganese ores generally occur in much the same way as limonite and often associated with it. The ores are known in almost every state but are worked in but few. About 65% metallic Mn should at least be present and for spiegeleisen there should be but little phosphorus. The deposits of the New England states especially in Va. and Mass. deserve mention, the ore being in much the same association as the limonites. Type 2a. The ores from the Franklinite deposit (Type 28) after being deprived of their zinc are smelted for spiegel.

Type 2a. Crimora Va. In Virginia the most productive mines are found. The largest are the Crimora Mines in Augusta Co.. They occur in elliptical basin, hollowed out of Potsdam sandstone, and filled with beds of sand and clay. Nodules of concretionary psilomelane are found scattered through the clay. The original source of the ore is doubtless the lower members of the Middle Cambrian (Auroral) containing of ferriferous shales. Lime was probably the precipitating agent. In northwestern Va. near the town of Dartmouth are the next most productive mines. Here like wise the ore occurs in superficial deposits of sands and ochreous dirt, resting on the Potsdam. Both pyrolusite and psilomelane are found.

Type 2b. Batesville Ark. Recent developments have brought to light extensive deposits of manganese ores in two districts in Ark. The first centers around Batesville in the northern central part of the state. The ore is in two forms of deposit, first as boulders like those already mentioned above, distributed through residual clay etc, resting on Subcarboniferous limestone. The ore was probably derived from veins originally in the limestone and set free by its weathering. The second class of deposits consists of nodules of manganese ore buried in a red matrix of siliceous iron ore that underlies the Subcarboniferous limestone referred to above.

The second manganese area is in southwestern Ark, and contains both true veins and pockets. Forthcoming publications of the Ark. Geol. Survey will probably fully describe these as well as the Batesville district. The presence of manganese in the Cherokee hematites has already been referred to (Type 2e) also at Butte Mont. (Type 17. p. 38). Mention should also be made of Red Rock, San Francisco Harbor, and of the New Brunswick and Nova Scotia mines. 54524 long tons of manganese ore were produced in 1887.

Day D.T. Mineral Res. 1888. p.423. 1883-84 p. 550.
E.& M.J. Cromora Manganese Mines, Va. Mar. 22. 1890.
Hoy H.Ores of Manganese and their use Pres. Nova Scotia Inst. Nat. Sci. 1864. p. 139 " " " " " "
Weeks J.D. Mineral Resources 1885. p.503. Res 1886.p.180.1887 p.164

MERCURY.

Cinnabar HgS Hg 86.2 S. 13.8
Metacinnabarite is a black sulphide of Mercury. Native mercury also occurs.

Mercury deposits are found in workable quantity in the U.S. only in California and in one locality in Nevada. In all cases cinnabar is the principle ore. The Cal. deposits are limited to the Coast Range and seem to have followed great basaltic eruptions of Post-pliocene age.

Type 55. New Almaden. Cinnabar with subordinate native mercury in a gangue of crystallized and chalcedonic quartz, calcite, dolomite and magnesite, forming a stockwerk or "chambered vein" in shattered metamorphic rocks(pseudodiabase, pseudo-diorite, serpentine and sandstone). There are two main fissures forming a sort of V with a wedge of country rock between. The ore bodies are in the fissures and also in the intervening wedge and have associated with them much attrition-clay. A great dike of rhyolite runs nearly parallel to the fissures and to this Becker attributes the activity of circulation which filled the vein. New Idria is further south high up toward the summit of the Coast Range. The ore is deposited in shattered metamorphic rocks of Neocomian (Lower Cretaceous) Age and in overlying Chico beds. The ore is accompanied by bitumen. Basalt is abundant 10 miles away. North of San Francisco other mines have been opened, among them the Oat Hill, Great Eastern and Great Western. The mines are situated in a region pierced by eruptions of basalt and andesite which doubtless gave impetus to the ore bearing solutions. The ores are deposited in both metamorphic and unaltered sedimentary rocks.

Type 55a. Sulphur Bank. This is in the same general region as the last but has been from its peculiar character one of the best known of ore deposits. A great flow of basalt has come down to the shores of Clear Lake from the west. Waters charged with alkaline (including ammonia) carbonates, chlorides, borates and sulphides and with CO_2, H_2S, SO_2 and marsh gas have circulated through it.

Sulphur and sulphuric acid have formed at the surface and the latter has dissolved the bases of the rock leaving pure white silica behind. Lower down cinnabar is found both in the basalt and in the underlying sedimentary rocks with other sulphides and chalcedony. Leconte attributed its precipitation to the cold surface waters charged with sulphuric acid, trickling down and meeting the hot alkaline solutions. Becker attributes the same to the ammonia set free toward the surface by deminished heat and pressure.

Type 55b. Steamboat Springs Nev. These are in Nevada only six miles from the Comstock Lode. Granite is the principal rock, while on it lie the metamorphic rocks of the Jura-Trias and much andesite and basalt. The hot springs coming up through small fissures deposit chalcedony in some places, carbonates in others, with cinnabar as well as gold. "Sulphides of arsenic, antimony, sulphides or

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Type 55a. Sulphur Bank. This is in the same general region as the last but has been from its peculiar character one of the best known of ore deposits. A great flow of basalt has come down to the shores of Clear Lake from the west. Waters charged with alkaline (including ammonia) carbonates, chlorides, borates and sulphides and with CO_2, H_2S, SO_2 and marsh gas have circulated through it.

Sulphur and sulphuric acid have formed at the surface and the latter has dissolved the bases of the rock leaving pure white silica behind. Lower down cinnabar is found both in the basalt and in the underlying sedimentary rocks.with other sulphides and chalcedony. Locally attributed its precipitation to the cold surface waters charged with sulphuric acid, trickling down and meeting the hot alkaline solutions. Becker attributes the same to the ammonia set free toward the surface by dominished heat and pressure.

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sulpho-aalts of silver, lead, copper and zinc; iron oxide and possibly iron sulphides; and manganese, nickel and cobalt compounds and a variety of earthy minerals "(Becker). Becker thinks the source of the cinnabar is in all cases in the underlying granite and that it has come up in solution with sodium-sulphide, and has been precipitated toward the surface by the other compounds in the hot alkaline waters with which it would remain in solution at greater depths, temperatures and pressure. The Steamboat Springs are often cited as metalliferous veins in active process of formation.

The Cal. cinnabar deposits have been often referred to vapors of the sulphide volatilized by internal heat and condensed above.

33825 flasks (76 1/2 lbs each) or 2.607.613 lbs were produced in 1887, almost all from Cal.. The highest production ever reached in the U.S. was in 1877 of 79396 flasks. The amount varies greatly from year to year.

Blake W.P. Quicksilver Mine at Almaden. Cal. A.J.S. II.17. 438.
Becker G.F. Quicksilver Deposits of the Pacific Slope. Monograph XIII. U.S.G.S. Chap. 17. Rec.
Cal. Geol. Survey I.p.68. On New Almaden.
Christy S.B. On the Genesis of Cinnabar Deposits A.J.S. June 1879. p.453. E.& M.J. Aug. 2. 1879. p. 65.
de Cortazar D. General Review of Occurrence etc. of Mercury. Reports & Awards G'p I. Centennial Exposition p. 196.
Laur. On Steamboat Springs. Ann des Mines 1863. 423.
Leconte J.& Rising. Metalliferous Vein formation at Sulphur Bank. A.J.S. July 1882. E.& M.J. Aug. 26. 1882 . p.109.
Leconte, J. On Steamboat Springs. A.J.S. June 1883 p. 424.
Genesis of Metalliferous Veins A.J.S. July 1883.
Phillips J.A. On Sulphur Bank Cal. Phil. Mag. 1871. 401. Quar. Jour. Geol. Soc. 35. 390. 1879.
Silliman B. Notes on the New Almaden Quicksilver Mines. A.J.S. II 38. 190.
Siveking. B.& H. Zeit. 1876. p. 45.
Rolland. Ann. des Mines XIV. 385. 1878.

NICKEL AND COBALT.

These two metals almost always occur together.

Millerite	NiS	Ni.64.4	S.35.6
Niccolite	NiAs	Ni 44.0	As 56.0
Linnaeite	Co_3S_4	Co.58.0	S.42.0

Also in small percentages in pyrrhotite, and a few oxidized compounds.

Type 16d. (See p. 26). Pyrrhotite beds. Lenticular masses of pyrrhotite interbedded in gneisses and schists as described for pyrite p.26. They are known at various places in the east. Openings have been made at Lowell Mass. Chatham and Torrington Ct. and Anthony's Nose N.Y., the last in search of pyrite for sulphuric acid. Nickeloc[illegible]s up to 3% of the ore, but these mines have never

sulpho-salts of silver, lead, copper and zinc; iron oxide and possibly iron sulphides; and manganese, nickel and cobalt compounds and a variety of earthy minerals "(Becker). Becker thinks the source of the cinnabar is in all cases in the underlying granite and that it has come up in solution with sodium-sulphide, and has been precipitated toward the surface by the other compounds in the hot alkaline waters with which it would remain in solution at greater depths, temperatures and pressure. The Steamboat Springs are often cited as metalliferous veins in active process of formation.

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Becker G.F. Quicksilver Deposits of the Pacific Slope. Monograph XIII. U.S.G.S. Chap. 17. Rec.
Cal. Geol. Survey I.p.88. On Nor Almaden.
Christy S.B. On the Genesis of Cinnabar Deposits A.J.S. June 1879. p.453. E.& M.J. Aug. 2. 1879. p. 85.
de Cortazar D. General Review of Occurrence etc. of Mercury. Reports & Awards G'p I. Centennial Exposition p. 196.
Laur. On Steamboat Springs. Ann des Mines 1883. 423.
Leconte J.& Rising. Metalliferous Vein Formation at Sulphur Bank. A.J.S. July 1882. E.& M.J. Aug. 26. 1882 . p.109.
Leconte.J. On Steamboat Springs. A.J.S. June 1883 p. 424.
Genesis of Metalliferous Veins A.J.S. July 1883.
Phillips J.A. On Sulphur Bank Cal. Phil. Mag. 1871. 401. Quar. Jour. Geol. Soc. 35. 390. 1879.
Stillman B. Notes on the New Almaden Quicksilver Mines. A.J.S. II 38. 190.
Stuvking. B.& H. Zeit. 1876. p. 45.
Holland. Ann. des Mines XIV. 385. 1878.

NICKEL AND COBALT.

These two metals almost always occur together.

Millerite	NiS	Ni.64.4	S.35.6
Niccolite	NiAs	Ni 44.0	As 56.0
Linnaeite	Co_3S_4	Co.58.0	S.42.0

Also in small percentages in pyrrhotite, and a few oxidized compounds.

Type 166. (See p. 26). Pyrrhotite beds. Lenticular masses of pyrrhotite interbedded in gneisses and schists as described for pyrite p.26. They are known at various places in the east. Openings have been made at Lowell Mass. Chatham and Torrington Ct. and Anthony's Nose N.Y., the last in search of pyrite for sulphuric acid. Nickeloc:us up to 3% of the ore, but these mines have never

amounted to much. Recently at Sudbury Can. mines originally opened for copper have been found rich in nickel. Great beds of pyrrhotite as much as 160' across have been opened up, in Huronian schists associated with diorite dikes. They promise to be very productive. Some chalcopyrite occurs with the pyrrhotite.

See literature under Type 16.

Credner H. On Anthony's Nose B.& H.Zeit. 1866. p. 17.
Eustis W.E.C. The Nickel Ores of Orford Quebec. M.E. 6: 209.
Peters E.D. The Sudbury Ore Deposits M.E. 1889. Ottawa Meeting.

Type 16c. Gap Mine. Lancaster Co. Penn. A great wedge or lense of hornblende rock appears to be here enclosed in mica schists. For a space from 6' to 30' it is impregnated with millerite, chalcopyrite, siderite quartz etc.. The millerite occurs as a coating, lining cracks. This has been described as a body of pyrrhotite but Fraser makes no mention of this mineral. A great trap dike is near.

Blake W.P. Mineral Resources. 1882. p. 399.
Fraser P. Rept. CCC 2nd Penn. Survey, p. 163.

Type 23a. Mine la Motte. Considerable pyrite occurs with the lead ores mentioned under Type 23. and this is separated in the ore dressing and treated by itself as it contains nickel and cobalt. Such pyrite is most abundant at Mine la Motte and considerable matte is made and shipped abroad. The siegenite in Potsdam sandstone is interesting but not rich enough to be available practically.

See under Type 23.

Neill J.M. Notes on the Treatment of Nickel and Cobalt Mattes at Mine la Motte. M.E. XIII. 634.

Numerous other localities of nickel ores, chiefly of an oxidized character have been reported, as at Webster, Jackson Co. N.C. in the olivene rock, dunite; in Nev. at the Lovelock Mines, Churchill Co., and near Riddle Station Douglass Co. Oregon. At the latter place the ores are hydrated silicates of magnesium and nickel associated with serpentines (which are derived from an altered olivine rock). These nickel minerals are doubtless an alteration product from olivine. Nickeliferous pyrrhotite is reported in the neighboring Co. Jackson, at Rock Point. Nickel ores have also been reported from Saline Co. Ark.. Millerite occurs in a vein with quartz gangue in black shales. It is not yet practically productive. Nickel is also reported in a rather fine conglomerate from Logan Co. Kan.. It occurs with manganese and limonite in the cement material of the rock. 183125 lbs of metallic nickel were produced in 1887, in the U.S.

Ark. Geol. Survey 1888. Vol. I. P. 34-35.
Dewey F.P. On the Nickel Ore of Russell Spr. Logan Co. Kan. M E.17.
Hodges. A.D. Note on the Occurrence of Nickel and Cobalt in Nev. M. E. 10/657.
Mineral Resources 1887. 126
Newberry S.B. Nickel Ores from Nev. A.J.S. III. 28. 122.
Wurtz.H. On the Occurrence of Cobalt & Nickel in Gosten Co.N.C. A J.S. II. 27. 24.

amounted to much. Recently at Sudbury Can. mines originally opened for copper have been found rich in nickel. Great beds of pyrrhotite as much as 180' across have been opened up, in Huronian schists associated with diorite dikes. They promise to be very productive. Some chalcopyrite occurs with the pyrrhotite.

See literature under Type 16.

Credner H. On Anthony's Nose B.& H.Zeit. 1866. p. 17.
Dustin W.H.C. The Nickel Ores of Orford Quebec. M.E. 6: 209.
Peters E.D. The Sudbury Ore Deposits M.R. 1889. Ottawa Meeting.

Type 15c. Gap Mine. Lancaster Co. Penn. A great wedge or lense of hornblende rock appears to be here enclosed in mica schists for a space from 6' to 30' it is impregnated with millerite, chalcopyrite, siderite quartz etc.. The millerite occurs as a coating, lining cracks. This has been described as a body of pyrrhotite but Fraser makes no mention of this mineral. A great trap dike is near.

Blake W.P. Mineral Resources. 1882. p. 389.
Fraser P. Rept. C6C 2nd Penn. Survey, p. 163.

Type 23a. Mine la Motte. Considerable pyrite occurs with the lead ores mentioned under Type 23. and this is separated in the ore dressing and treated by itself as it contains nickel and cobalt.

Such pyrite is most abundant at Mine la Motte and considerable matte is made and shipped abroad. The stegenite in Potsdam sandstone is interesting but not rich enough to be available practically

See under Type 23.

Neill J.M. Notes on the Treatment of Nickel and Cobalt Mattes at Mine la Motte. M.E. XIII. 634.

Numerous other localities of nickel ores, chiefly of an oxidized character have been reported, as at Webster, Jackson Co. N.C. in the olivene rock, dunite; in Nev. at the Lovelock Mines, Churchill Co., and near Riddle Station Douglass Co. Oregon. At the latter place the ores are hydrated silicates of magnesium and nickel associated with serpentines (which are derived from an altered olivine rock). Those nickel minerals are doubtless an alteration product from olivine. Nickeliferous pyrrhotite is reported in the neighboring Co. Jackson, at Rock Point. Nickel ores have also been reported from Saline Co. Ark., Millerite occurs in a vein with quartz carrying in black shales. It is not yet practically productive. Nickel is also reported in a rather fine conglomerate from Logan Co. Kan.. It occurs with manganese and limonite in the cement material of the rock. 1881&2 lbs of metallic nickel were produced in 1877, in Pa, & Ala. S.

Ark. Geol. Survey 1888. Vol. I. P. 34-35.
Dewey F.P. On the Nickel Ore of Russell Spr. Logan Co. Kan. M E.17.
Hodges. A.D. Note on the Occurrence of Nickel and Cobalt in Nev. M. E. 10\857.
Mineral Resources 1887. 126
Newberry S.B. Nickel Ores from Nev. A.J.S. III. 28. 123.
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TIN.

Cass-terite SnO_2 Sn, 78.67 0.21.33

The sulphide stannite, is a rather rare mineral.

Cassiterite occurs in small stringers and veins on the borders of granite knobs or bosses either in the granite itself or in the adjacent rocks in such relations that it is doubtless the result of fumarole action consequent to the intrusion of granite.

It would appear that the tin oxide may have been formed from the fluoride. A favorite rock for the ore is the so-called greisen a mixture of quartz and muscovite or lithia-mica and probably an original granite altered by fumarole action. Topaz, tourmaline, fluorite, are found with the cassiterite indicating fluoric and boracic fumaroles. Cassiterite seems also to crystallize out of a granite magma with the other minerals. Cassiterite being a very heavy mineral also accumulates in stream gravels like gold, affording the stream tin. When of concentric character it is called wood tin.

Type 56. Black Hills. Knobs of granitic rock containing cassiterite disseminated in a mass of albite and mica or associated with immense crystals of spodumene. Columbite, tantalite and beryl are also found. There are two granite knobs which are best known, the Etta and the Ingersoll. The former is a conical hill 250' high by 150' x 200', piercing mica and garnetiferous slates.

Tunnels show it to have a concentric structure, first a zone of mica, second a zone of great spodumene crystals with albite " greisen" and cassiterite in the interstices, and lastly a mixture of quartz and feldspar as a core. Other tin-bearing granites occur as dikes as much as 80' wide, and bearing the so-called greisen and tin ore in quartz. They are called segregated veins by Carpenter who doubts thier igneous character, probably on good grounds.

No tin is yet commercially produced. The tin deposits extend also into Wyo..

Blake W.P. Mineral Resources. 1884-84 p. 602. Rec.
" A.J.S. Sep. 1883. p.235. E.& M.J. Sep. 8. 1883.
" Tin Ore Deposits of the Black Hills. M.E. 13. 691.
Carpenter F.R. Prelim. Rep. of Dak. Sch. of Mines. 1888. Also M.E. 17. 570.
E.& M.J. Tin in the Black Hills. Nov. 29, 84. p.358. Nov.6.86.p.325
Mineral Resources in General under Tin.

Tin ores as stream tin have been found in gold washings in Mont. and Idaho. It is also known in the Temescal Mtns. southern Cal. and according to Blake is in various small veinlets in a granite region. This locality attracted much interest years ago but has never yielded any practical results.

Blake W.P. Occurrence of Wood Tin in Cal. Idaho and Mont. Mining and Scientific Press. Aug. 5. 1882. San Francisco.
Hanks H.G. Cal. State Mineralogist. Rept. 1884. p. 121.
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Campbell H.D. Tin Ore, Cassiterite, in the Blue Ridge in Va. "The Virginias" Oct. 1883.

Ledoux A.R. Tin in N.C.. E.& M.J. Dec.14. 89. p.521. See also Feb. 1887. p.111.

McCreath and Platt. Bull. Iron & Steel Assoc. Nov. 7. 83 p.209.

Robertson W. London Mining Jour. Oct. 18. 1884.

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Blake W.P. Mineral Resources 1884. p.598.

Hitchcock. C.H. Discovery of Tin Ore and Emery at Winslow Me. E.& M.J. Oct. 2. 1880. p.218.

Hunt T.S. Remarks on the Occurrence of Tin Ore at Winslow Me. M.E. I. 373.

Jackson C.T. Tin Ore at Winslow Me. Proc. Bost. Soc. N.H. XII. 267.

App. Remarks on the geographical distribution of the western ore deposits. General Review of the region of the Cordilleras on the western border of the country. Elevated Plateau rising from the Mississippi to the Rocky Mountain Range, then various ranges of general north and south, or north west and south east trend with broad valleys between, then the Colorado plateau; then the Wahsatch, then the Great Basin, with various subordinate north and south ranges, then the Sierra Nevada, then the great valley of California, then the Coast Range, finally the Pacific Ocean. From the Archaean to the close of the Carboniferous there were granite islands around which active sedimentation proceeded. At the close of the Carboniferous the elevation of the Wahsatch and the region of eastern Nevada occurred. At the close of the Jurassic the elevation of the Sierra Nevada took place. The elevation of the Rocky Mountain system came at the close of the Cretaceous, and of the Coast Range at the close of the Miocene Tertiary. Smaller and unimportant oscillations have occurred since. Each elevation was accompanied by foldings, faultings and extensive outpourings of eruptive rocks. These fractures and the solfatar ic action resulting from the dying volcanic activity constitutes the primary cause of the formation of the ore deposits which in some cases lie in ranges along the lines of faulting or disturbance; in others are irregularly scattered. We can recognize the Coast Range belt with Mercury and Chromium, the California Gold belt in the western Sierras, the Silver belt of Utah on the western flank of the Wahsatch, and a belt in Arizona from south east to north west on the contact between Palaeozoic limestone, mostly Carboniferous, and the Archaean. The other areas are scattered and apparently exhibit no such grand general relations to these geographical and geological disturbances.

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Raymond R.W. Geographical Distribution of Mining Dist. in the U.S. M.E. I. 33.
40th Parallel Survey. Vol. III. Chapter 1.
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A few general conclusions suggest themselves from the preceding pages.

(1) The extreme irregularity in the shape of metalliferous deposits (instances cited) and from this the unwisdom of the U.S. law in the west which is based on fissure veins. The only practicable method is that a man should own all that is embraced in his property lines whether the ore body outcrops outside or not. "A square location is the square thing" (Raymond).

(2) The very general proximity of eruptive rocks in some form to the ore bodies. Except in the case of iron, there are only a few where these are not present and apparently strong factors in the circulation which formed the ore. The lead and zinc deposits of eastern and western Missouri and the neighboring states, and of New York and Virginia are almost the only ones, and we are justified in concluding that eruptive rocks are of great importance.

(3). We know from the investigations of Sandberger and others that the dark silicates of many rocks contain percentages of the common metals. The choice is open whether to refer our ore to original dissemination in these and derive it by gradual concentration probably at great depths, or to some indefinite unknown source.

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THE CARBON SERIES.

Peat--Lignite--Coal--Graphite--Petroleum--Asphalt--Natural Gas.

General description of the condition of the vegetable growths on the surface today, formed of C. H. O. N. Cellulose $C_6H_{10}O_5$. Unless, however, the fallen vegetation is protected by water it decays, passes into gases, and leaves only the small mineral residue contained in it behind,=a slow combustion with a small ash. Swamps are the chief places for the collection and conservation of vegetable tissue. Freshets and floods collect also and bury much in the deltas of streams. (Dismal Swamp, Red River Raft, Mississippi Delta).

Newberry's Illustrative Diagram, (Slightly Abridged).

Plant Tissue.

Residual Products.	Evolved Products.
Peat.	Carbonic Acid CO_2
Lignite.	Carbonic Oxide CO
Bituminous Coal.	Carburetted Hydrogen
Semi-Bituminous Coal.	and other hydrocarbon gases. (Natural Gas.)
Anthracite.	Water.
Graphitic Anthracite.	Asphalt.
Graphite.	Petroleum
Ash.	Asphaltic Coals.

Bailey J.W. On the detection of Spinally dotted or Scalariform Ducts etc. in Anthracite Coal. A.J.S. II. 1. 407.

Bunker J.M. Vegetable Origin of Anthracite. A.J.S. I. 24. 172.

Cooper F. New Theories of the Formation of Coal. E.& M.Jour. Aug. 13. 1881. p.103.

Dawson J.W. On the vegetable Origin of Coal. Proc. Geol. Soc. London. Vol.XV. 626. A.J.S. II. 31. 290.
On Spore Cases in Coal. A.J.S. III. 1. 256.

Ehrenberg. On the Microscopic Constituents of the Ash of Fossil Coal. Ann. Mag. Nat. Hist. XVI. 1845. 69-70/A.J.S.II.1.124

E.& M.Jour. Formation of Coal. Dec. 3. 1881 p.373.
" " " Aug. 26. 1882. p. 110.

Fraser P. Classification of Coals. M.E. 6. 430. Penn. 2nd Geol. Survey. M.N. p. 144.

Gueppert. On the Origin of the Coal of Silesia. Proc. Brit. Assoc. From the Athenaeum. Sep. 19. 1846.

Hunt T.S. The Origin of Anthracite. Nat'l Acad. Nov. 1880.

Jackson C.T. Bituminization of Peat and Conversion into Coal. A.J.S. I. 34. p.395.

Johnson W.R. The Heating Power of Various Coals. See also A.J.S. I. 49. 310.

Lesley J.P. Manual of Coal and its Topography. Phila. 56. p. 224. See also A.J.S. II. 22. 302.

Lesquereux L/ On some Questions concerning the Coal Formations of North America. A.J.S.II. 28. 21. Excellent Statement of

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Logan Sir W. On some Questions concerning the Coal Formations of North America. A.J.S.II. 28. 21. Excellent Statement of

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See also A.J.S. II. 33. 208. 35. 375.
Lyell C. The Origin of Coal Fields and the time required for their Formation. A.J.S. II. 16. 33. From Proc. Roy. Soc. Great Britan Mar. 18. 1853.
MacFarlane T. Coal Regions of the U.S. N.Y. Rec.
Nathurst E.O. Formation of Coal. E.& M.J. Mar. 17. 83. p. 194.
Newberry J.S. On the Mode of Formation of Cannel Coal. A.J.S. II. 23. 212.
" Origin and Relations of the Carbon Minerals. Anuals N.Y. Acad. Sci. Vol. II. 1882. No.9. Rec. On the Physical
" Conditions under which Coal was formed. S. of M. Quarterly. Vol. IV. p. 169. Geol. Surv. Ohio. Vol. II? p. 125.
Prime F. Rept. on Coal. Repts on Exhibits at the Centennial. Repts and Awards. Vol I. p. 50.
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" On the Resinous Nature of Coal. Bost. Soc. N.H. April 7
" 1852. A.J.S. II. 14. 70.

Geological Classification.

Peat- Recent or at most Quaternary.
Lignite- Post carboniferous, i.e. Triassic, Jurassic, Cretaceous, Tertiary. In this country chiefly Upper Cretaceous and Lower Tertiary. This term is less applied than formerly as we now know the Cretaceous coals to be as good as any. It is not strictly used in these notes.
Coals Proper. Carboniferous.
Graphite- Principally Archaean, but known also in connection with coals. We do not know that the Archaean Graphite is certainly of vegetable origin.
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PEAT.

Brande, On Peat and its Products. Proc. Roy. Soc. Jan. 31. 1851.
Johnson, Peat and its Uses as Fertilizer and Fuel.
Lewitt T.H. Facts about Peat.
Lesquereux L. Sphagnum as a Peat Maker. Hayden's Reports 1872. A. J.S. III. 6. 383.
Lyell. Principles of Geology. Vol. II. pp. 502 ff.
Senft. Humus- Marsch- Torf- und Limonit- bildungen.

In temperate climate peat is derived mainly from sphagnum a moss. It contains as well all kinds of vegetable matter and often various animal remains. Many peat bogs are old lakes and ponds and hence are underlain by shell marl; many also by bog iron ore. (See Type 1). Peat does not occur south of 36° N. Lat. nor north of 45° S. Lat. It is found very generally in our northern states. With us

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S. Lat. It is found very generally in our northern states. With us

it is more important as a fertilizer (muck) than fuel, but in foreign countries it is of very great importance as fuel. (Ireland, Germany). Preparation for use is necessary.

Analyses of Virginia Peat by Prof. Johnson of Yale.

	I	II	III	IV
Water	20.00	20.00	Not Est	Not Est
Vol. Matter	50.05	52.59	62.56	65.74
Coke	24.97	25.44	31.21	31.81
Ash	4.98	1.97	6.23	2.45

The Ash is chiefly CaO, Fe_2O_3 and insoluble Silicates.
View of a peat bog. Section do. Historical reference to the peat craze of 1867.

LIGNITES AND COALS.

Classification.

See Report AC. Second Penn. Geol. Survey p. 15. do. Report M.M. p. 128. Trans. Inst. M.E. Vol. VI. p. 430.

	Per Cent Volatile Hydrocarbon.	Fixed Carbon	Ash.	Fixed Carbon Ratio---------- Vol. Hydrocarbon
Anthracite	0-7	100-93	X	100/0 to 12/1
Semi Anthracite	7-10	93-90	X	12/1 to 8/1
Semi Bituminous	10-18	90-82	X	8/1 to 5/1
Bituminous	18-40	82-	X	5/1 to
Cannel	40-66		X	

Post Carboniferous Coals are called Lignites. Lignites are also called (especially abroad) Brown Coals. Other classifications are employed which are based on physical properties, such as cleavage, character of burning, coking or not coking etc.. See Ures Dict. Ed. 1845 p.969. Watts Dict. Chem. Vol. I. p. 1032.
Rogers H.D. General Rept. First Penn. Geol. Surv. Vol.II. pt.2.p983
Ohio Geological Survey Rept. Progress. 1870.
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Lignites or Post-Carboniferous Coals.

The Coal (Lignite) areas of Va. and N.C. are generally called the Richmond Field and the Deep and Dan River Fields. They are in Triassic or Jurassic strata, which are much broken and seamed by trap dikes (diabase) converting the coal in many places into a natural coke, (Carbonite). The areas form several narrow N.& S. strips along the border of Va. and N.C.. The coal cannot compete in any great amount with the better fuel brought from the western part of Va..

Chance H.M. The Deep River Coal Fields of N.C. M.E. 13. 517.
Coryell M. Eastern Va. Coal Fields. M.E. 3. 228.
Heinrich O.J. The Midlothian Va. Collieries M.E. 4. 308.
Lesley J.P. Coal Formation of S.Va. Proc. Amer. Phil. Soc. Jan. 1862. A.J.S. II. 34. 413.
Leyell.C. On the Structure and Probable Age of the Coal Field of the James River near Richmond Va.Geol. Soc. Lond. April 14. 1847. A.J.S. II. 4. 183

it is more important as a fertilizer (muck) than fuel, but in Germany it is of very great importance as fuel. (Ireland, Germany). Preparation for use is necessary.

Analyses of Virginia Peat by Prof. Johnson of Yale.

	I	II	III	IV
Water	20.00	20.00	Not Det	Not Det
Vol. Matter	50.05	52.59	62.56	65.74
Coke	24.97	25.44	31.21	31.81
Ash	4.98	1.97	6.23	2.45

The Ash is chiefly CaO. Fe_2O_3 and insoluble Silicates.

View of a peat bog. Section do. Historical reference to the peat craze of 1857.

LIGNITES AND COALS.

Classification.

See Report A6. Second Penn. Geol. Survey p. 15. do. Report M.M. p. 128. Trans. Inst. M.E. Vol. VI. p. 430.

	Per Cent Fixed Volatile	Fixed Carbon Ash.Ratio
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Semi Anthracite	7-10	93-90 X
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Bituminous	18-40	82- X
Cannel	40-66	X

	Vol.Hydrocarbon
	100% to 12%
	12% to 8%
	8% to 5%
	5% to

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Olmstead D. On the Sandstone and Coal of N.C. of the Age of the Richmond Coal basin. A.J.S. II.19. 430 from the Geol. Report N.C. 1824.
Raymond R.W. The Natural Coke of Chesterfield Co. Va. M.E.11. 446.
Rogers W.B. On the Relations of the New Red Sandstone of the Conn. Valley to the Coal bearing Rocks of Eastern Va. and N.C. A.J.S. II. 19. 123. Proc. Bost. Soc. N.H. 1854. p. 14.
Woldridge A.S. Geological and Statistical Notice of the Coal Mines in the Vicinity of Richmond Va. A.J.S. I. 43. 1.
Wurtz. H. Preliminary Notes upon the Carbonite or so-called Natural Coke of Va. M.E. 3. 456.

Coal (lignite) in the Rocky Mtn. and Plateau Regions.

A bread belt said to be 400 miles wide runs up and down the Rocky Mtn. region and affords excellent coals of all characters, on on both sides of the continental divide. These beds of fuel are of the greatest value to the country lying near them, for smelting and all industrial purposes and also for household purposes in the treeless prairie region on the east of them. They belong to the Laramie.

1. New Mexico. Coals are known in Doña Ana Co. in the south but are not extensively developed. Coal is also reported from near Silver City Grant Co. somewhat anthracitic. Coming south in Socorro Co. at Carthage are the San Pedo Mines where very excellent coking coals are mined and extensively used in N.M. and Arizona. The seam is 6'. Over in the western part of the territory near the Arizona line in Valencia and Bernalillo Co's. are the mines which at present are the most productive of all. The chief centers are Gallup and Defiance and the coal is mined for the Atlantic and Pac. R.R. which transports it as far as Cal.. A number of seams from 4' to 9' are exposed. The existence of anthracite (due to local igneous outbreaks) in Santa Fe county has long been known. The mines are known as Los Cerillos and produce small amounts yearly. The Monero Mines in Taos Co. produce some coal for the Durango branch of the D & R.G.R.R. The mines near Raton, Colfax Co. were the first to be extensively worked and are now the most important source of fuel for the A.T.& S.F.R.R. A number of beds are known from 3' to 8 1/2' thick. The coal field is virtually a southern extension of the Trinidad area of Col.. Raton and Blossburg are the centers.

In 1882 N.M. produced 157.092 short tons, in '85 306.202. in '87 508.084.

Leconte John. Cretaceous Anthracite near Santa Fe. N.M. A.J.S. II. 13
Mineral Resources Especially 1883 & 1884.
Raymond R.W. Remarks on the Occurrence of Anthracite in N.M. M.E.2.1.

Arizona. The Gallup field of N.M. runs across the line into Apache Co. Ariz. but is not as yet much developed. Other coal seams are recorded in Pinal Co.

E.& M.J. The Deep Creek Coal Fields Ariz. Dec. 17. 1881. p. 404.
Mineral Resources 1883 & 1884 p. 18.

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THE EASTERN SLOPE.

As the prairie region rises in the foothills the upturned edges of the Cretaceous rocks appear from under the Tertiary lake deposits of the plains. In their upper members, the Laramie Stage, are found the coal seams, extending along the foothills with broken intervals from the southern portion of the state to its northern boundary. In the extreme south in Las Animas Co. is the Trinidad field, which is the northern prolongation of the Raton district of N.M.. The entire field covers perhaps 750 sq. miles. The principal seam is the Trinidad from 6' to 14' thick but Wheelers Survey records in all 32 seams although only two or three are workable.

The coals make excellent coke. The chief mining towns are El Moro, Sopris and Starkville, they furnish more coal than any other one district. (Views and Geological sections).

Coming north the next important district centers about Walsenburg. Important mines have been worked for some years just north of the Cucharas River and recently important developments have been made at Rouse. (Views and sections).

The next important mining center to the north is near Canon City at the entrance to the Royal Gorge. The coal which is of a superior quality is obtained from a small basin south of Canon City at Coal Creek, Oak Creek, Rockvale and Williamsburg. Two workable seams are known both rather narrow being but from 3 1/2' to 4' and numerous smaller ones. Out in the prairie 10 miles east of Colorado Springs a limited exposure of Laramie strata is found at Franceville and in it a 10' seam. This is extensively worked by the Denver and New Orleans R.R.. North of here the coal does not occur for some distance, Sedalia being the next mining district. Much attention has lately been given to the so-called Denver basin, and its geology will form the subject of a forthcoming monograph by S.F Emmons.

Nearly twenty miles east of Denver at Scranton in the upper Laramie, mines in lignite of a rather inferior character have been opened. West of Denver the Laramie is again found in the foothills and is mined at various points. Golden is an important one, then in order going north come Louisville, Langford and Erie. The seams run from 3' to 12' averaging 6'. These are the oldest mines and were opened in the early sixties. These mines of the eastern slope are usually classified as the Northern, the central and the southern divisions.

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Only one coal area occurs in the parks (see p. 5. VIII) and this is at Como on the U.P.R.R. One seam 5' to 7' thick is worked furnishing what is called the Lechner coal.

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THE WESTERN SLOPE.

Great interest is now centering on the coal seams of La Plata Co. in the south west near Durango. They are developed to some extent and promise to supply the neighboring portions of N.M. and Utah in the near future. The coal is in the usual Laramie and forms a number of seams. The Mammoth was reported at 90' but really is a great interlamination of shale and coal, the largest seam being but 7'. Considerable mining has already been done to supply the local smelters and general demand. Coming north the country is very badly broken by eruptive outpourings, and the next important coal area is met about the middle latitudes of the state.

In the Elk Mtns of Gunnison Co. are a number of outlying fields, some changed to anthracite (Crested Butte) while others are coking coals. Some as Coal Basin and Gunnison Mtn are not yet reached by rail. Coal Basin is described by J.S.Newberry as an eliptical valley from which the strata dip away on all sides, showing five or six workable beds. Still further north the upturned Laramie beds run north westerly in a great so-called Hog-back. This brings to the surface in Jerome Park a long exposure of coal seams which are now reached by the Midland R.R.. Again below Glenwood Springs along the Grand River this ridge crosses the stream making the coal accessible and important mines are developing at Newcastle.

Here are six good seams of which one, the thickest is 45' and another 16', the rest smaller. (Detailed description).

The coal bearing strata then bear away to the north west to the White River country where they are abundant but not yet developed.

In 1875 Col. produced 98838 tons, in 1880 375000, in 1885 1.398.796, in 1889 2.373.954. The Trinidad region produced rather more than one third of this total.

E.& M.J.our. The Coal Fields of La Plata Co. Col. June 29. 78 p.441
Hayden F.V. Prelim. Rept. 1869. See also 40th Parallel Survey Vol. III. p.481.
Hewett,G.C. The Northwestern Col. Coal Region. M.E. XVII. 375.
Hills,R.C. In Vol. II. Halls Hist of Col.
King,Clarence The Green River Coal Basin. 40th Parallel Survey Vol. III. p.451
Lakes A. Annual Rpts Col. Sch.of Mines especially 1889 Rec.
Lesquereux L. On the Formation of the Lignite Beds of the Rocky Mtn Region A.J.S. III. 7. 29. 546.
McNeil J. Reports of the State Inspector of Coal Mines.
Mineral Resources. All the Volumes.
Newberry J.S. The Coals of Col. S.of M.Quarterly IX. 327 Rec.
Potter W.B. The Character and Composition of the Lignite Coals of Col. M.E.V. 365. Rec.

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Ashburner C.A. Coal Production in Utah in 1886 M.E. 16. 356.
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Montana. Much attention has been given in the last few years to Montana coal, especially in connection with railways. Coal is known in several districts, which however do not seem to equal those of the country to the south . The most important field is at Bozeman on the U.P.R.R. in the southern central portion of the state. A 4' seam affords the railways its fuel for the Mont. division. They are placed by G.H.Eldredge (10th Census Vol. XV p.695 and 739) below the Fox Hills probably in the Colorado Stage.
North of Bozeman is the Judith field, and further east, south of Stillwater is the Rock Creek, and north of Billings is the Bull Mtn. Then to the north, near the Great Falls of the Missouri is the Great Falls Field opened along Sand Coulée Creek, Eldredge referred this to the Lower Cretaceous and fossils since described by J.S.Newberry prove it to be below the Dakota Stage. Much poor lignite is also known along the Missouri River.
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Davis W.M. Relation of the Coal of Mont. to the Older Rocks. 10th Census XV. p.697.
Eldredge G.W. The Coals of Mont. 10th Census XV. p. 739.
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COAL (LIGNITE) ON THE PACIFIC SLOPE.

California. There is one small coal field in Cal. just east of San Francisco known as the Monte Diablo Field. This contains three workable seams (Sections). The coal is not of very excellent quality and is chiefly used for steaming as it contains much sulphur. Other miner lignites have been worked to some extent.

Cal. receives its coal from Oregon, Wash. British Columbia., and returning grain ships, from Australia and Great Britain. Cal. produced in 1861. 6620 tons, in 1870. 141890, 1880. 153725, 1885. 77485, 1887. 50000.

Goodyear W.A. Coals of the Pacific Coast. Rec.
" Rept of Cal. State Mineralogist 1887.
Mineral Resources.

Oregon. There is one coal field in Oregon known now to cover several hundred square miles, the Coos Bay about 100 miles north of the Cal. line. One seam of about 4 1/2' is mined at several points. The coal is of fairly good quality but the harbor is bad and only small vessels can be used and even these may be storm bound. The coal is called Tertiary. The production of Oregon. 1860. 3145 tons, 1870. 20567, 1880. 35415, 1885. 50000 / in 1887. 31696. The earlier years are the receipts at San Francisco. Goodyear W.A. Coal Mines of the Pacific Coast p. 83 Rec. Mineral Resources. 1886. and 1887.

Washington. The coal area around Puget Sound is extensive and furnishes excellent coal that is shipped all along the coast. The coal is found along a belt 10-34 miles back of Puget Sound and extending from British Columbia south almost to the Columbia River.

The coal is accessible in comparatively few places because of a great development of gravel, of volcanic disturbances, and of deep forests that hinder prospecting. The coals occur in the Laramie which is from 8-14000'. They vary in quality from a soft air slacking lignite to good bituminous coking coals. Their properties are largly due to the geological disturbances through which they have passed and to their nearness to igneous outbreaks. Bellingham Bay on the north in Whatcome Co. is the oldest mining district but was abandoned in 1878. The New Castle and Renton Mines are east of Seattle and the Franklin further away on the same railroad.

The Wilkson field is southeast of Tacoma and contains eight or ten beds from 3' to 14'. Another exposure occurs at the headwaters of the Yakima River on the eastern slopes of the Cascade Mtns at Roslyn.(Sections) The production of Washington, 1860 Bellingham Bay 5490. 1865. 14446. 1869. 20552. 1880. 123741. 1885. 380250. 1887. 689823. The earlier years are the receipts at San Francisco Goodyear W.A. Coal Mines of the Pacific Coast. p.99.
Mineral Resources. Especially 1886. p.337. Rec.

COAL (LIGNITE) ON THE PACIFIC SLOPE.

California. There is one small coal field in Cal. just east of San Francisco known as the Monte Diablo Field. This contains three workable seams (Sections). The coal is not of very excellent quality and is chiefly used for steaming as it contains much sulphur. Other minor lignites have been worked to some extent.

Cal. receives its coal from Oregon, Wash. British Columbia, and returning grain ships, from Australia and Great Britain. Cal. produced in 1881. 6820 tons, in 1870. 141890, 1880. 1837?3, 1885. 77485, 1887. 50000.

Goodyear W.A. Coals of the Pacific Coast. Rec. Mineral Resources.
Rept of Cal. State Mineralogist 1887.

Oregon. There is one coal field in Oregon known now to cover several hundred square miles, the Coos Bay about 100 miles north of the Cal. line. One seam of about 4 1/2' is mined at several points. The coal is of fairly good quality but the harbor is bad and only small vessels can be used and even these may be storm bound. The coal is called Tertiary. The production of Oregon. 1880. 3183 tons, 1870. 20557, 1880. 35415, 1885. 50000 in 1887. 31096. The earlier years are the receipts at San Francisco. Goodyear W.A. Coal Mines of the Pacific Coast p. 83 Rec. Mineral Resources. 1886. and 1887.

Washington. The coal area around Puget Sound is extensive and furnishes excellent coal that is shipped all along the coast. The coal is found along a belt 10-34 miles back of Puget Sound and extending from British Columbia south almost to the Columbia River.

The coal is accessible in comparatively few places because of a great development of gravel, of volcanic disturbances, and of deep forests that hinder prospecting. The coals occur in the Laramie which is from 8-14000'. They vary in quality from a soft air slacking lignite to good bituminous coking coals. Their properties are largely due to the geological disturbances through which they have passed and to their nearness to igneous outbreaks. Bellingham Bay on the north is Whatcome Co. is the oldest mining district but was abandoned in 1878. The New Castle and Renton Mines are east of Seattle and the Franklin further away on the same railroad.

The Wilkson field is southeast of Tacoma and contains eight or ten beds from 3' to 14'. Another exposure occurs at the headwaters of the Yakima River on the eastern slopes of the Cascade Mtns at Roslyn.(Sections) The production of Washington.1880 Bellingham Bay 5490. 1885. 14446. 1889. 20552. 1880. 12574l. 1885. 830250. 1887. 689823. The earlier years are the receipts at San Francisco Goodyear W.A. Coal Mines of the Pacific Coast. p.99. Mineral Resources. Expecially 1886. p.837. Rec.

Newberry J.S. A.A.A.S. 1856.
Willis B. 10th Census. Vol. XV. p.

Note. These coals extend into British Columbia and are extensively mined on Vancouver Island, whence San Francisco draws a large part of its supply.

Alaska. Coal is also known in a number of places in Alaska. Admiralty Is., St. Johns Bay near Sitkan and in Cook Inlet. Passing vessels occasionally use it.
Mineral Resources. 1884. p.19.
E.& M.Jour Jan. 17. 1880 p.47.
Moss R.J. Coal in the Arctic Regions. Proc. Roy. Soc. Dub. May.1873

Note. Texas. Some lignite is mined in Texas. There are three areas according to E.T.Dumble State Geologist. (a) the Eolignitic on the north east, (b) the Central in the middle of the State, (c) the Mountainous in the south west. The last named is Laramie, the first is Eocene. About 75000 short tons were produced in 1887.
Dumble E.T. Mineral Resources 1886 p.347. Rec. Brazos Field N.E. 9.493
Note. Incoherent lignite beds are known in Miss. and at Gay Head Martha's Vineyard and accumulations of vegetable material more or less carbonized are elsewhere known but are of no practical value.

Table of Analyses of Lignites, also Areas.

	Volatile Hybroc.	Fixed Carbon	Ash	S	H_2O	Sp.Gr	SgM
Va.& North Carolina	30.5	56.4	6.35	2.19	1.95		
Wyoming Rock Spring	36.3	54.4	1.73		7.00		20.000
Colorado Erie	34.5	47.3	3.40		14.8		
" Canon City	35.8	50.9	3.15	1.04	5.03	1.363	
" El Moro	29.82	56.41	12.82	0.41	0.95		
San Juan Mine	37.30	54.39	6.39	0.864	1.112		
" Crested Butte	5.36	39.73	2.77		1.53		
Newcastle.Seam E.	41.53	43.60	7.97	0.909	1.85		
New Mexico Raton	35.00	51.50	10.40		3.10		
Utah Pleasant Valley	39.75	49.95	5.50	0.27	4.80	1.27	
California							
Oregon Coos Bay	32.59	41.98	5.34		20.0		
Wash. Ty. Newcastle	44.84	43.86	7.41		4.16		
Alaska Admiralty Id	37.96	57.49	1.55	0.73	3.00		
Germany Br. Coals							

These analyses are mostly taken from the Mineral Resources U.S. 1883-84 and 1885. Several also from Vol. 15 10th Census.

COALS PROPER. I. BITUMINOUS.

Doddow & Eaman Coal, Iron and Oil (Unscientific).
Lesley J.P. Manual of Coal and its Topography. Philadelphia 1856
MacFarlane J. Coal Regions of America Rec.
Prime F. The Coals of the U.S. 10th Census Vol. XV p.605 Rec.
Taylor R.C. Statistics of Coal. ( ).

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Wilkie R. 10th Census. Vol. XV. p.
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Dumble R.T. Mineral Resources 1886 p.647. Rec.

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" San Juan Mine	37.30	54.59	6.39	0.364	1.112	
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The bituminous coals of Carboniferous Age occur in four great areas in the U.S. and one in Nova Scotia. In describing them they will be taken up from west to east in order to lead up geographically to the anthracites. In the U. S., 120,000 square miles are estimated to contain workable beds.

1. The Alleghany Area. 59000 sq. miles. In Penn. Ohio, West Va Md., Va., Ky., Tenn., Ga., Ala.,

2. The Eastern Central Area 47,000 sq miles in Ill., Ind., and W West Ky..

3. The Michigan Area 6700 sq miles, in the southern Peninsular of Mich.. This area is so buried under glacial drift as to be but imperfectly explored and not much developed. Views.

4. The Western Central Area 78000 sq miles (not all of workable coal) in Iowa, Miss.? Kan., Ark., Ind.,Ty. and Texas.

5. The Acadian Area 2200 sq. miles in Nova Scotia. If coal is put on the free list, this area will be of vast importance to the New England States.

THE WESTERN CENTRAL AREA.

Indian Territory. The important productive coal measures begin in the south in Indian Ty. in whose eastern portion they are strongly developed. The mines are situated at Ataka, Lehigh and McAllister and supply the southwestern railways. They are operated under lease from the Choctaw tribe.

Arkansas. The coal area of Ark. occurs in the western central part of the state and has attracted much attention of late years especially since the geological survey spread information about it.

The coal is both bituminious and semianthracite. The workable beds run 4'-6'; at Coal Hill in the most productive mine the cross-section is Coal 21"-22" Shale 4' Coal 24"-25". The analyses show these coals to be high in sulphur. In the older books they are often spoken of as the Spadra coals from one of the mines.

Mineral Resources. All the Volumes.

Winslow.A. Annual Rept. Ark. Geol. Surv. 1888. Vol. III.

Kansas. In Kansas the coal occupies a strip about four counties deep on the east. The Cherokee seam in the southeast is the most productive. It ranges from 3'-4'. It furnishes a good bituminous coal which is coking and is used in the local lead and zinc works. (See Type 25). Osage Co. in the eastern central part of the state also furnishes much coal, but the seam is only from 12"-20". All these coal belong in the middle coal measures.

The Kansas area runs north into southeastern Neb. where some small mining is done.

Hicks L.E. A.A.A.S. 1880. p. 217.

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Pumpelly R. State Geol. Rept on Iron Ores and Coal Fields. 1874.
Swallow G.C. On the Coal Measures of Mo. State Rep. 1855. See also A.J.S. II. 26. 113.

Iowa. Nearly the southern half of Iowa is underlain by coal but the productive portions are mostly along the Desmoines River. The coal seams vary from 2' up to 5' or 6' averaging about 4'. Mahaska, Keokuk, Lucas and Polk are the most productive counties. The coals are inclined to be sulphurous and are only adapted to heating purposes.
Geological Reports of Iowa.
White C.A. Character of the Unconformability of the Ia. Coal Measures on the older Rocks. A.J.S.II. 45. 351.

THE EASTERN CENTRAL AREA.

Illinois. Two-thirds of Ill. are underlain by the coal measures and a vast amount of coal is mined. The most productive counties are in a diagonal line from the northern central part of the state south to the Miss. River. La Salle Co. on the north produces rather the most and next is St Clair Co. opposite St Louis. Vermillion Co. on the east is also an important dist. Sixteen coal seams are reported from Ill. but they do not furnish especially excellent fuel as the moisture and sulphur are high. From one field however in the southwest in Jackson Co. a very good quality comes known as the Big Muddy Coal.
Comstock. T.B. The Fossil Fuel of Ill. etc. E.& M.J. May 25th 1867 and subsequently.
Johnson J. On the Wilmington Ill. Coal Fields. M.E.3 180.
Wonthen A.H. Fuel Resources of Ill. A.A.A.S. 17.

Indiana. The Ill. Coal fields are extended into Indiana covering a strip on the southwestern corner. There are three beds of coking coal 4 1/2' to 10' and three open burning 2 1/2- 5' Clay Co. is the most productive and affords the well known "Indiana block coal", much used for iron furnaces.
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Kentucky. The same field crosses the Ohio River into K'y. and forms the western K'y. field. Twelve seams are known of only four of which much mining has been done. The coals are apt to be high in Sulphur but some occurrences of good quality have been lately announced. The field forms a broad synclinal with some minor folds having the Green River in the axis of the trough. The Breckenridge Cannel coal occurs on the eastern rim of the basin and is noted for its large yield of oil on distillation.
Reposts of the Kentucky Geological Survey.
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This Eastern Central Field is separated from the Alleghany by the southern extension of the Cincinnati uplift (See p. 4. IV). The intervening country is formed by the earlier Palaeozoic strata.

THE MICHIGAN AREA.

The Central portion of the southern peninsula is formed by the coal measures. The beds are covered by a heavy cap of drift, and are difficult to locate. The mining too has proved very wet and as the coal is of inferior grade the developments are comparatively small. The seams run 4' and less.

THE ALLEGHANY AREA.

This is the largest and most productive area and being in the oldest portion of the country it has been most extensively developed. It extends from Penn. to Ala. along the line of the Alleghanies.

Alabama. The coal fields of Ala. are of comparatively recent development but they have grown to be of the greatest importance. The close association of coal, iron ore, and limestone has given them a great impetus. (See also Type 6). There are three fields, the Black Warrior, which is the largest, the Cahaba and the Coosa. They are separated by the foldings and erosion of the strata. Fifty coal seams are recorded in Ala. but all are not at present available. Jefferson Co. in the Warrior field is the largest producer, and of this the principal part comes from the Pratt seam.

Ashburner C.A. The Development and Statistics of the Ala. Coal Fields for 1887. M.E. 17. 206. Rec.
Hunt T.S. Coal & Iron in Ala. M.E. 11. 233. E & M.J. Mar. 30 83.p.173
Lyell Ch. Coal Field of Tuscaloosa Ala. A.J.S. II. 1. 371. See also II. 2. 228.
McCalley H. Rept on the Warrior Coal Field. Ala. Geol. Surv. 1886.
Porter, J.B. Iron Ores & Coals of Ala. Ga. & Tenn. M.E. 15. 170.
Rothwell R.P. Ala. Coal and Iron. M.E. 2. 144.
Smith E.H. Repts of Progress Ala. Geological Survey.

Georgia. The coal measures just cross the border of Ga. and appear in its northwestern county, Dade. A seam varying from 13' to 14' with an average of 4' is quite extensively mined and furnishes about 300000 tons yearly.

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Bowron W.M. The Geology and Mineral Resources of the Sequatchie Valley. Tenn. M.E. 14. 174.
Colton H.E. The Upper Measure Coal Fields of Tenn. M.E. 14. 292.
E.& M.J. Jan. 7th 1888. Tenn. Number.

Eastern Kentucky. A broad strip of coal bearing strata comes in eastern Ky. and furnishes excellent and abundant coals which are being more and more developed as transportation facilities increase. Twelve to fifteen seams are recorded of which one of two reach 3' or 9'. The Elkhorn is one of the best known and furnishes excellent coke. Cannel coal is more extensive in Ky. than in any other state, the Hunnewell cannel being an important coal for gas production.

Virginia. From Ky. the coal area runs across into southwestern Va. where it forms a small area with several eastern outliers. There are two areas in the western part of the atate. The more easterly is in the section known as the Appalachia and is formed by the outlier of the main Alleghany field. Further west is the Pocahontas field directly connected with the main field. An excellent coke is produced in the last named. The recent railroad developments have served to increase the production very greatly. The Jura-trias coals near Richmond have already been mentioned.

West Va . Almost the entire state is underlain by coal, 48 out of 54 counties containing it, and about 14 being active producers. The beds in general dip north westerly forming with the Ohio field a great synclinal trough. The coal is especially developed along the Kanawha and New Rivers in the west and the upper waters of the Monongahela in the north and in the panhandle. The Pittsburg seam is the principal one, affording 10' and more of coal. With increased facilities of transportation the state will be more and more productive although now one of the largest.

Killbrew J.B. Notes on the Coal Field of S.W.Va. E.& M.Jour Jan. 19th 1889. p.64.
Buck S.M. Notes on the hard Splint Coal of Kanawha Valley M.E.10.81
Morris S.F. The New River Coal Field of W.Va. M.E. 8. 261.

Ohio. Nearly the eastern half of Ohio is underlain by coal making the state a very large producer. The beds correspond, with a few local variations, to those of Penn.. There are 13 recognized No I and No VI (from the bottom up) are the most mined, and only two or three others are much developed. No I is the well known Brier Hill block coal and is used directly in the furnace. It is especially mined in the north western part of the field. No VI is

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the coal of the Hocking Valley and is mined and shipped largely to the west. The seam varies from 4' to 13'.

Andrews E.B. Observations on a seam of Coal. A.J.S. II. 38. 194.
Parallelism of Coal Seams. A.J.S. III. 3. 56.
Comparison between the Ohio and W.Va. sides of the Alleghany Coal Field. A.J.S.III. 10. 283.
Hunt T.S. The Coals of the Hocking Valley.O. M.E. 2. 273.
The Coal and Iron of the Hocking Valley O. M.E. 7. 313.
Orton E. The Bedford Cannel. E.& M.J. Mar. 8. 1884. p. 175.
Ohio Geol. Survey. Early volumes and especially Econ. Geol Vols V and VI.
Tappan Judge, Cannel Coal in Ohio. A.J.S. I. 18. 376.

Pennsylvania. The western portion of Penn. is largely coal bearing and contains the most productive area of bituminous coal in the U.S.. The region around Pittsburg takes the lead and contains the best known seams. The Pittsburg bed is the most important it runs from 6' to 10' thick and affords the coking coal for the Connelsville ovens. There are 12 or 15 seams in all, others of which are of great importance and are known by local names.

Views and Sections.

E.& M. Jour. The Connelsville Coke Region of W.Pa. Mar. 8. 1879. p. 163. Map.
Mines of the Pittsburg & Wheeling Coal and Coke Co. Feb 14th. 1885. 104.
Hill. F.A. Geology and Mining in the Northern Coal Fields Of Pa. M. E. 15. 699
Kimball J.P. The Quemahoning Coal Field of Somerset Co. Pa. T.J. M.E. 12. 469.
Lesley J.P. The Geology of the Pittsburg Coal Region M.E. 14. 618.
Ray. A. The Mahoning Valley. Coal Region M.E. 4. 183.
de Rivere E. The Mines of Mineral Coal in Penn. Ann. des Mines (5) VII. 1885. p. 459.
Shinn W.P. Pittsburg. Its Resources and Surroundings. M.E. 3. 11
See general works on Coal Macfarlane etc. 2nd Penn. Geological Survey. Local Reports.

Analyses of Bituminous Coals.

	Volatile Hydroc.	Fixed Carbon.	Ash.	S.	H	O.	Sp.gr.	Sg.Ms
Penn. (Pittsburg Seam)	20.1	59.6	8.23	0.784	1.26			12302
West Va.Va.(Kanawha F'd)	35.9	57.3	3.47	0.60	3.25		1.328	17000
Ky. (Eastern F'd)	39.0	56.0			5.00			12871
Tenn. (Sewanee Seam)	27.0	62.0	9.0					5100
Ala. (Warrioe Seam)	31.%	61.6	5.42	0.92	1.50			5530
Ohio (Sharon Seam)	32.4	57.5	3.13	0.88	6.95		1.247	10000
Ind. (Block Coal Clay Co)	32.5	61.5	2.5		2.5			6500
Ill. (Vermillion Co.)	23.3	51.3	10.60		9.47			36800
Kentucky (Western F'd.)	36.0	57.38	2.82	10.24	3.30		1.241	3700

the coal of the Hocking Valley and is mined and shipped largely to the west. The seam varies from 4' to 15'.

Andrews E.B. Observations on a seam of Coal. A.J.S. II. 38. 194.

Prevalition of Coal Seams. A.J.S. III. 8. 88.

Comparison between the Ohio and W.Va. sides of the Allegheny Coal Field. A.J.S.III. 10. 253.

Hunt T.S. The Coals of the Hocking Valley.O. M.M. 2. 273.

The Coal and Iron of the Hocking Valley O. M.M. 7. 313.

Orton E. The Bedford Cannel. E.& M.J. Mar. 8. 1884. p. 175.

Ohio Geol. Survey. Early volumes and especially Mem. Geol Vols V and VI.

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Ray. A. The Monongahela Valley. Coal Region M.E. 4. 1876.

de Rivera E. The Mines of Mineral Coal in Penn. Ann. der Mines (5) VII. 1855. p. 659.

Platt W.P. Pittsburg, Its Resources and Surroundings. M.E. 3. 11

See general works on Coal Measures etc. 2nd Penn. Geological Survey. Local Reports.

Analyses of Bituminous Coals.

Volatile Fixed

	Hydrog.	Carbon.Asb.	S.	H O.	Sp.gr.	Sp.Wt.
Penn. (Pittsburg Seam)	20.1	80.6	8.23	0.786	1.28	12502
West Va.(Kanawha P'd)	36.3	57.3	5.47	0.80	1.22	1.222 17000
Ky. (Western P'd)	39.0	56.6			8.00	12871
Penn.(Sewarne Seam)	27.0	82.0	9.0			8100
Alaz (Warrior Seam)	31.[illegible]	61.6	5.42	0.32	1.30	8330
Ohio (Sharon Seam)	32.4	57.3	5.18	0.33	4.95	1.24[illegible] 10000
Ind.(Block Coal Clay Co)	32.8	61.5	2.8		2.8	4500
Ill.(Vermillion Co.)	23.3	51.3	10.60		9.47	12800
Kentucky (Western P'd.)	36.0	87.05	2.32	10.24	2.20	1.241 8700

	Volatile Hydroc.	Fixed Carbon.	Ash.	S	H_2O	Sp.gr.	Sg.Ms.
Michigan	49.0	45.0	2.00	2.00	2.00		6700
Iowa	44.0	43.5	7.50				13000
Missouri, Rich Hill.	42.62	41.14	13.70	2.69	2.54		23100
Kansas, Crawford Co.	35.72	33.97	9.00		1.29		17000
Arkansas.	See under Semi-bituminous.						
Nova Scotia.	34.1	61.4	4.77	2.39			2200
England (Staffordshire).	37.8	59.6	2.50				12000
Wales.	36.5	57.4	6.25				
France.							2000
Belgium.							518
Germany.							
Australia.							

These analyses are mostly taken from the Mineral Resources U.S. The State Reports, and Höfers Kohlen und Eisenerzlager-stätten Nord Amerika's.

SEMI-BITUMINOUS COALS.

The principal areas of these coals are in outliers of the main Alleghany field as we come east through Penn. and Md.. The strata are extensively folded along N.E. & S.W. axes and in outlying synclinal basins on the hill tops are found these scattered fields. In Md. we have the Cumberland which is a prolongation of the Potomac field of W.Va.. The Pittsburg seam 14' thick is the chief one mined and furnishes a most excellent coal that is shipped away in great quantities. In Penn. are the Broadtop, the Johnstown, the Snowshoe, the McIntyre, the Barclay and the Blossburg. The semibituminous coal of Ark. has already been referred to.

For literature see under Bituminous.

Table of Analyses, Semi-Bituminous Coals, Areas.

	Volatile Hydroc.	Fixed Carbon	Ash	S	H_2O	Sp.Gr	Sg.Ms
Blossburg, Pa.	13.5	69.9	9.13	0.66	1.05		50
Barclay "	17.1	71.9	9.55	0.66	0.75		
McIntyre "	17.940	71.151	9.125	0.834	0.950		
Snow Shoe "							
Johnstown "	16.540	74.456	5.959	1.360	1.185		
Broadtop "	17.5	74.6	7.50		0.30	1.327	25
Cumberland Md.	15.5	74.0	10.5			1.33	150
Coal Hill Ark	10.341	76.119	8.351	3.672	1.017	1.333	

These analyses are taken from Repts G. and M.M., Penn. Survey and from Macfarlane.

ANTHRACITE COAL.

Still further to the east, the volatile matter in the coal continues to decrease and in eastern Penn. are found the anthracite basins. These are synclinal troughs of crescentic outline, five in number. (1) the Schuylkill Field, including the Tamaqua and Pottsville districts. (2) the Western Middle Field, including the

	Volatile Hydros.	Fixed Carbon.	Ash.	S	H_2O	Sp.gr.	Sq.Mls.
Michigan	45.0	45.0	9.00	3.00	2.00		8700
Iowa	44.0	43.5	7.80				18000
Missouri, Rich Hill.	42.38	41.14	14.70	2.69	3.64		28700
Kansas, Crawford Co.	36.72	53.27	9.00		1.29		17000
Arkansas.	See under Semi-bituminous.						
Nova Scotia.	34.1	61.4	4.77	2.39			2200
England (Staffordshire).	37.8	59.8	2.80				13000
Wales.	38.3	57.4	6.28				
France.							2002
Belgium.							818
Germany.							
Australia.							

These analyses are mostly taken from the Mineral Resources U.S. The State Reports, and Höfers Kohlen und Kiesenerlagerstätten Nord Amerika's.

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For literature see under Bituminous.

Table of Analyses, Semi-Bituminous Coals, Areas.

	Volatile Hydros.	Fixed Carbon	Ash	S	H_2O	Sp.gr	Sq.Mls
Blossburg, Pa.	18.3	69.9	9.15	0.65	1.05		50
Barclay "	17.1	71.3	9.55	0.60	0.75		
McIntyre "	17.960	71.151	9.125	0.654	0.950		
Snow Shoe "							
Johnstown "	16.840	74.456	8.909	1.060	1.185		
Broadtop "	17.8	74.6	7.80		0.30	1.327	25
Cumberland Md.	15.8	74.2	10.8			1.33	150
Coal Run W.Va.	18.241	70.119	8.351	3.672	1.017	1.353	

These analyses are taken from Repts S. and M.M., Penn. Survey and from Macfarlane.

ANTHRACITE COAL.

Still further to the east, the volatile matter in the coal continues to decrease and in eastern Penn. are found the anthracite basins. These are synclinal troughs of crossentic outline, five in number. (1) the Schuylkill Field, including the Tamaqua and Pottsville districts. (2) the Western Middle Field, including the

Shamokin, Mahanoy and Broad Mtn Districts. (3) the Eastern Middle Field, including Drifton, Hazelton, Audenreid and other centers. (4) The Northern Field including the Lackawana and Wyoming districts. (5) The Layalsock Field with Bernice. In (1) fifteen beds have been recognized, with a total thickness of 113', 80' being in workable beds. In (4) there are twenty beds, of which nine as a maximum are workable. The Mammoth seam is the best known (reaching 80'-90' by foldings) and being often over 29'. This is no advantage for a 6' seam is cheaper to mine.

Views and sections,

Ashburner C.A. Engineers Club, Phila. Penn. June 21. 1884.
The Classification and Composition of the Penn. Anthracite Coal M.E. 14. 706. Rec.
The Anthracite Coal Beds of Penn. M.E. 11. 136.
See also local Reports and Maps of the 2nd Geol. Survey Penn.
Claghorn C.R. Notes on the Bernice Anthracite Coal Basin Sullivan Co. Penn. M.E. 17. 606.
Cox E.B. Notes on a peculiar Variety of Anthracite. M.E. 7. 213
Lesley J.P. Coal beds in the Subcarboniferous of Penn. A.J.S. III 10. 153. Letters describing coal beds near Broadtop.
Silliman B. Notice of the Anthracite Region in the Valley of the Lackawanna, and of Wyoming on the Susquehanna. A.J.S. I 18. 303 Also ,Notes on a Journey to Mauch Chunk and other Anthracite regions of Penn. A.J.S. I 19. 1

The Rhode Island Area. The most easterly outcrop of coal is in R.I.. It is also lowest in volatile matter and approximates graphite. Various attempts have been made to mine and use it but not very successfully. The Carboniferous rocks extend also into Mass.

Emmons A.B. Notes on the Rhode Island and Mass. Coals. M.E.13. 510.
Hayes A.A. On Rhode Island Coal (Portsmouth) A.J.S.II. ii. 267
Hitchcock E.Sr. The Coal Fields of Bristol Co. and of Rhode Island A.J.S. II. 16. 327.
Holley A.L. Notes on the Iron Ore and Anthracite Coal of Rhode Island and Mass. M.E. 6. 224. E.& M.J. Dec. 1. 77. p.399.

The Colorado anthracite, that near Santa Fe and that in Washington have already been referred to.

Table of Analyses, Anthracite Coals. Areas.

Semi Anthracite	Volatile Hydro.	Fixed Carbon	Ash	S	H O	Sp.Gr	Sg.Ms
Layalsock (Bernice)	3.100	83.344	3.230	1.031	1.295		14(?)
Carbondale (Northern F'd)	7.07	90.2	2.7				
Wilksbarre "	7.68	89.9					
Lykens Valley(SouthernF'D) Anthracite.	8.35	88.2	2.9				
Pa.South.F'd(Schuylkill)	4.27	83.3	8.13	0.641	3.09	1.63	146.

Blamoxin, Hainsey and Broad Mtn districts. (3) the Eastern Middle Field, including Drifton, Hazelton, Audenried and other centers. (4) The Northern Field including the Lackawanna and Wyoming districts. (5) The Lehigh Field with Pennie. In (1) fifteen beds have been recognized, with a total thickness of 112', 80' being in workable beds. In (4) there are twenty beds, of which nine are workable. The Mammoth seam is the best known (reaching 30'-90' by foldings) and being often over 20'. This is advantage for a 6' seam is cheaper to mine.

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Claghorn C.R. Notes on the Pennsylvania Anthracite Coal Basin Sullivan Co. Penn. M.E. 17. 603.

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Hitchcock E.Jr. The Coal Fields of Bristol Co. and of Rhode Island A.J.S. II. 16. 327.
Molloy A.L. Notes on the Iron Ore and Anthracite Coal of Rhode Island and Mass. M.E. 8. 288. E.& M.J. Dec. 1. 77. p.393.

The Colorado anthracite, that near Canon Pc and that in Washington have already been referred to.

Table of Analyses, Anthracite Coals. Areas.

		Volatile	Fixed				
Coal Anthracite	Hydro.	Carbon	Ash	S	H 0	Sp.Gr	Sp.Ht
Lykens Valley (Berries)	2.100	82.344	3.250	1.031	1.295		14(?)
Carbondale (Northern P'd)	7.07	90.2	2.7				
Tilkeberre "	7.62	83.3					
Lykens Valley (Southern P'd)	8.85	86.3	2.9				
Anthracite.							
Pa. South. P'd (Schuylkill)	4.27	83.8	8.18	0.641	3.09	1.63	144.

	Volatile Hydro.	Fixed Carbon	Ash	S	H_2O	Sp. Gr	Sg. ns.
Pa. West Mid. F'd (Shamokin and Mahanoy)	3.72	81.1	11.1	0.90	3.16	1.65	91
Pa. East Mid. Fd (Lehigh)	3.08	86.4	5.92	0.50	4.12	1.61	35
Pa. North Mid. Fd (Wyoming and Lackawana)	4.38	83.7	8.20	0.73	3.42	1.57	198
Rh. I'd Newport.	5.42	74.4	12.5	0.28	7.62		500
Gt. Britain & Wales	6.0	92.5	1.5				
Anthrac. Lignite Santa Fe New Mexico	3.18	88.71	5.21		2.90		
Anthrac. Lignite Crested Butte. Cal.	5.16	90.24	4.40		1.20		
Pure Graphite		100				2.089	

These analyses are chiefly taken from the Mineral Resources U.S. 1883-84 and Rep't M.M. 2nd Geol. Survey. Penn.

Mention made of the Acadian Coal Area in U.S. and general review of the structural relations of all the Areas.

Theories of the Formation of Coal.

The Swamp or Peat Theories that coal seams are fossil beds of peat compacted together.

The Raft Theory, that the vegetable material has been accumulated in river deltas. Various inorganic and laboratory hypotheses which have few claims to credence. The Swamp Theory is the most reasonable. The character of the plant remains in Carboniferous coals (Sigillarids, Lepidodendrids, Ferns, Conifers) all lower forms of vegetation.

Table of Coal Production in 1000 Long Tons.

	1850	1860	1870	1875	1880	1885	1887
Rhode Island			14		6		6
Penn. Anthracite	3321	8143	15648		28640	34228	39506
Penn Bituminous			7800		18425	20647	30866
West Virginia					1400	3098	4836
Virginia			669		100	567	795
Maryland	196	788		2342	2136	2865	3278
Ohio			2527		7000	6078	10301
Kentucky				500	1000	1700	1933
Tennessee					600	893	1900
Alabama			11	60	323	2225	1950
Georgia					100	134	313
Illinois			2624		6115	9791	10278
Indiana				800	1500	2375	3217
Michigan			28		100	45	71
Missouri			621	750	844	2750	3209
Iowa					1461	3579	4473
Kansas					550	1212	1597

	Hydro.	Carbon	Ash	S	H_2O	Sp. Gr	Sp.Gr.
							Volatile Fixed
Pa.West Mid.Pt'd(Shamokin and Mahanoy)	3.72	81.1	11.1	0.90	3.16	1.65	91
Pa.East Mid.Pd(Lehigh)	3.08	86.4	5.92	0.50	4.12	1.61	35
Pa.North Mid.Pd(Wyoming and Lackawana)	4.38	83.7	8.20	0.73	3.42	1.57	198
Kan. I'd Newport.	5.42	74.4	12.5	0.28	7.62		500
Gt.Britain & Wales	6.0	92.5	1.5				
Anthrac. Lignite Santa Fe New Mexico	5.18	88.71	5.21		2.90		
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Maryland		196	788		2342	2138	2855	3278
Ohio				2527	7000	6078	10301
Kentucky					500	1000	1700	1933
Tennessee						600	893	1900
Alabama				11	60	383	2225	1950
Georgia						100	134	313
Illinois				2824		6115	9791	10278
Indiana					800	1500	2375	3317
Michigan				88		100	45	71
Missouri				621	750	844	2750	3209
Iowa						1461	3579	4473
Kansas						550	1213	1597

	1850	1860	1870	1875	1880	1885	1887
Indian Territory					221	500	686
Arkansas						134	150
Wyoming			105	300	580	807	1170
Utah					225	190	180
Colorado			13	98	462	1356	1791
New Mexico						275	508
California					175	64	50
Oregon				30		744	31
Washington					175	339	772
Montana						77	10
Australia						2749	
Elsewhere							108
Gt Britain		71979				159351	
France, Belgium		18800				36880	
Germany		12000				72113	
Nova Scotia						77	
Other Countries		14962				35957	
Total U.S.		16513	30182	46712	65414	95832	129.975
Total Foreign		110000				309000	

These figures are mostly taken from the 10th Census and the Mineral Resources . 1885 and 1887.
Analyses of Statistics. Remarks on the equivalent foot pounds of work.

ASPHALT AND ASPHALTIC COALS.

These seem to be inspissated petroleum and have been found filling fissure-veins and beds. The Grahamite of W.Va., the Albertite of N.B. ,the Uintahite of Colorado and Utah, and the Ionite of Cal. belong here. The Grahamite filled a fissure vein cutting across the coal measures. They are used as gas enrichers.

Asphalt oozes to the surface in the Cal. oil region and in Trinidad. It also saturates a Swiss limestone. They are much sought at present for material for street pavements.

General and Foreign Literature. Broadhead G.C. Centennial Repts and Awards G'p I. p.2 On Asphalt, Bitumen ,Petroleum etc.

Green F.V. Asphalt and its Uses. M.E. 17. 355

Kimball J.P. On the occurrence of Grahamite in the Huasteca Mex. , and Notice of the Geology of thet Region .A.J.S.III.12.277

Mauross N.S. Notice of the Pitch Lake of Trinidad. A.J.S. II.20.153

Peckham S.F. Notes on the Origin of Bitumens with expts etc. Am. Phil. Soc. X. 445. Also Abs. A.J.S. II. 48. 1[illegible]1. Rec.

Silliman B.Note on the Wellsongongite etc. A.J.S.II. 48. [illegible]35

Wall. Rept on Trinidad Asphalt N.J.Geol.Soc. XVI. 467

Wurtz. H. A Theory of Asphalts. E.& M.Jour. July 27. 18[illegible]9 p.73 Rec

California. Hilgard E.W. Min.Resources U.S.1883-84 p.93[illegible]

Powell S. On Ionite a new Mineral .From Ione Amador CO, Cal. Mining & Sci. Press S.F. Mar. 24 1877.A.J.S. III 16. 154

Colorado. Newberry J.S. Grahamite in Col S. of M.Q. VII[illegible] 332

	1850	1860	1870	1875	1880	1885	1897
Indian Territory					221	500	885
Arkansas						134	150
Wyoming				105	300	580	807	1170
Utah						295	190	180
Colorado				13	98	482	1356	1791
New Mexico							275	508
California						175	64	50
Oregon					30		744	31
Washington						175	339	772
Montana							77	10
Australia							2749	
Elsewhere								105
Gt Britain			71979				159351	
France, Belgium			18800				56880	
Germany			18000				72115	
Nova Scotia							77	
Other Countries			14982				55957	
Total U.S.			18515	30185	45715	65414	95832	129.975
Total Foreign			11000				30900	

These figures are mostly taken from the 10th Census and the Mineral Resources . 1885 and 1887.

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Silliman B.Note on the Wellsborogite etc. A.J.S.II. 48. 75

Wall. Rept on Trinidad Asphalt N.J.Geol.Soc. XVI. 457

Wurtz. H. A Theory of Asphalts. E.& M.Jour. July 27. 1879 p.73 Rec

California. Hilgard E.W. Min.Resources U.S.1883-84 p.95

Powell S. On Ionite a new Mineral .From Ione Amador Co. Cal. Mining & Sci. Press S.F. Mar. 24 1877.A.J.S. III 16. 154

Colorado. Newberry J.S. Grahamite in Col S. of M.Q. VIII. 332

New Brunswick. Hind.H.Y. Prelim. Rept. on the Geology of N.B. Chap. V
Hitchcock.C.H. The Albert Coal of Albertite of N.B. A.J.S. II 39. 267
Jackson C.T. On the Asphaltic Coals of N.B. Proc. Bost Soc Nat. Hist. April 1850. p.279. A.J.S. II. 11. 392
Peckham S.F. On the Probbale Origin of Albertite and allied Minerals A.J.S. II. 48. 362. Many Ref. given.
Ohio. Leeds A.R. Asphaltic Coal from the Shale of the Huron River. Ohio. Aun. Lyc. N.H. June 1875. A.J.S. III. 10. 503
Utah. E.& M.Jour. Uintahite a new Variety of Asphaltum from the Uintah Mtns. Utah Dec. 26. 1885. p. 431
Blake W P.Uintahite E.& M.J. Dec 26. 1885/ A.J.S.III. 31. 231
Locke J.M. Gilsonite or Uintahite a new Variety of Asphaltum from Uintah Mtns. Utah M.E. 16. 162
Raymond R.W. Note on a Specimen of Gilsonite from Uintah Co. Utah M.E. 17. 113 Uintahite ,Albertite etc.
Wurtz H. Uintahite a variety of Grahamite.E.& M.J. Aug 10. 1889 p. 114
West Virginia. Fontaine Wm. M. Grahamite at the Ritchie Mine A.J S. III. 6. 409 Also Notes on the W.Va. Asphaltum Dep/ A.J.S. III. 6. 409 i e. on W.Va. Grahamite.
Lesley J.P. On an Asphaltum Coal Vein in W.Va. Am. Phil. Soc. VII, 1860. 183
Wurtz H. On Grahamite A.J.S. II. 42. 420/

Note. Shales occur at times so soaked with bituminous matter as to yield copious distillation products. They are virtually a coal enormously high in ash, and have been distilled inthe early manufacture of kerosene.

GRAPHITE [illegible] Paint, lubricant, crucib

Graphite in New Brunswick A.J.S. II. 14. 280
E.& M.Jour. Occurrence, production etc. Apr. 17. 1886 p. 283
" " Vacation Notes on N.Y. Ticonderega Graphite Aug 24. 1889 p. 158.
Dawson J.D; On the Graphite of the Laurentian of Canada Quart. Jour Geol. Soc. 1869. 112. A.J.S. II. 50. 130 Rec.
Fraser P. Relations of the Graphite deposits of Chester Co. Pa. to the Geology of the rocks containing them. M.E. 9. 730
Nason F.L. Bull . 4. p.12, N.Y. State Museum.
Newberry J.S. Origin of Graphite S.of M. Quarterly VIII. 354.
Walker J.A. General Article. E.& M.J. Sept. 22. 83. p. 186. Rec.

Graphitic schists are not uncommon in the Archaean, in the region of rocks of metamorphic character. Graphite has been mined at Ticonderega N.Y. and at various places throughout the New England States, also in Canada. The greater part now used is imported from Ceylon. The old mines near Ticonderega were in a series of elliptical chimneys filled with calcite andgraphite probably marking decided swell and pinches along a vein. They were long since worked out. The present workings are on a bed of graphite schist

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VII. 1880. 183
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GRAPHITE COALS.

Graphite in New Brunswick A.J.S. II. 14. 280
M.& M.Jour. Occurrence, production etc. Apr. 17. 1886 p. 288
" Vaseation Notes on N.Y. Tioenderoga Graphite Aug24. 1889
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Dawson J.D: On the Graphite of the Laurentian of Canada Quart. Jour
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some 2 1/2 miles west of Hague on Lake George. The schists consist of graphite and quartz with about 10% of the former. It is crushed and washed. Graphite in many instances is undoubtedly a highly altered form of organic (vegetable) matter (R.I. Graphitic Anthracite). The origin of the metamerphic rocks, however, leaves much to speculation, nor as yet can anyone speak decidedly for all the contained graphite.

PETROLEUM. NATURAL GAS.

PETROLEUM.

Andrews E.B. Petroleum in its Geological Relations A.J.S. II 42 23. See also Rock Oil, its Geological Relations and Distribution A.J.S. II. 32. 85.

Buck W.J. Early Accounts of Petroleum in the U.S. Hist. Soc. Penn Mar. 15 1876, Mineral Pamphlet, Cornell Library Vol I.

Carll J.F. 2nd Geol. Surv. Penn. Rept. III P.270 Rec.

Dana J.D. System of Mineralogy. Chap. on Minerals of the Hydrocarbon Gp.

Evans E.W. On the Action of Oil Wells (Development of Cavity theory A.J.S. II. 38. 159

E.& M.Jour. Kerosene etc. History of a great industry in years past, and the possibility of its revival. Feb.9 84.p.99.

" " The Mendeleeff Theory. Theory of the Formation of Petroleum Dec 22 1883 -. 525

Hoefer Hanns. Petroleum and its Contents. Reviewed Aug 4 1883 p. 81 E.& M.Jour.

Hitchcock C.H. Petroleum in N.Amer. Geol. Mag. IV 36. 1867 Neues Jahr. 1867 p. 623 Rec.

Hunt T.S. Contributions th the Chemical and Geological History of Bitumens and Pyroschists or Bituminous Shales A.J.S. II 33 157 See also Chemical and Geological Essays.

Krämes & Böttger. Fisheil Theory. Ber. d. Chem. Gesell. 20. 295. Am. Chem. Jour. 11. 130

Lesley J.P. On the Geological Position of Oil Wells. Proc. Am. Phil. Soc. Vol. X. p.139. A.J.S. II. 41. 139.

Newberry J.S. Origin and Distribution of Petroleum in the U.S. Proc. Nat. Acad. 1865.

" " Origin and Relations of the Carbon Minerals. Annals N.Y. Acad. Sci. Vol. II No. 9. 1882

Orton E. Geol. Ohio Vol VI Chap. II p.60. Rec.

Peckham S.F. 10th Census Vol X p.3 Rec. Full References up to 1880 in this Monograph.

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Hitchcock C.H. Petroleum in N.Amer. Geol. Mag. IV 35. 1867 News Jan. 1867 p. 523 Rec.

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very early period but the former came into extended use about 1860 and the latter in the last ten years. (Historical remarks). Salt water is well nigh universally associated with the oil and gas.

The Penn. and N.Y. Fields. The productive oil districts extend in two principal belts, running from northeast to southwest. The most northerly begins in Alleghany Co. N.Y. with the Alleghany district, and runs southwest through Cattaraugus Co. N.Y. and McKean Co. Penn. (Bradford Dist.); Warren and Forest Co.s (Warren & Forest Dist); and runs out in Venango Co. (Venango Dist). The next belt begins in Clarion Co. and extends southwest into Butler (Butler Dist); and Beaver Co.s (Beaver Dist). There are other small fields in Westmoreland and Greene Co.s in the southern part of the state. The first discoveries were in the Venango Dist. at Titusville just over the border of Venango Co. and later at Oil City in the county itself. In subsequent years the other fields were opened. The early wells developed the fact that in a 1000' and more of Catskill Shales there were three beds of porous sandstone (oil sands) that contained petroleum and, in exceptional cases a fourth. When all were present the oil was found in the lowest bed. One or more might be wanting and then the lowest of the remainder contained it. The wells were first sunk in the river valleys but later ones spread back in the hills and developed subordinate sandstone beds lying higher than the oil sands proper and these were called mountain sands. Another lower lying series has been tapped in the Bradford field. These sandstone beds are a very porous rock sometimes a decided conglomerate. They have a thin lenticular shape being proved by the drill to be thickest in the middle of the fields and tapering to a feather edge in the outskirts. They were early regarded as originally sand bars or river beds but probably they only swell and pinch as sandstone beds always do. The necessary combination is an impervious roof (Generally slate) a porous receptiole, (here sandstone) and a bituminous source (lying below).

New York Ashburner C.A. Petroleum and Natural Gas in N.Y. State M.E. 16. 906

Silliman B.Sr. Notice of a Formation of Petroleum called the Oil Spring (near Cuba Alleghany Co. N.Y.) A.J.S. 23. 97

Wrigley H. The Amount of Oil in Penn. and N.Y. E.& M.Jour. June 17, 1882 p. 515.

Penn. E.& M.Jour. The Penn. Oil Regions. Their Geology and History September 3 1881. p. 150.

Oil Wells of Penn. and Ohio A.J.S. II. 30. 305.

Ashburner C.A. The Bradford Oil Dist. Penn. M.E. 7. 316.

The Product and Exhaustion of the Oil Region of Penn. and N.Y. M.E. 14. 419.

Carll J.F. 2nd Geol Survey Penn. Rept. III.

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M.E. 16. 908
Gilliam B.Sr. Notes of a Formation of Petroleum called the
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Wrigley H. The Account of Oil in Penn. and N.Y. N.& M.Jour.
June 17. 1882 p. 815
Penn. N.& M.Jour. The Penn. Oil Regions. Their Geology and History
September 3 1881. p. 180.
Oil Wells of Penn. and Ohio A.J.S. II. 30. 305.
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Penn. Wrigley H.E. 2nd Geol. Survey Rept. J. Petroleum of Penn. Rec.
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The Eastern Ohio and West Va. Fields. Various scattered occurrences are known in the first named state. The Mecca Field of Trumbull Co. affords lubricating oils from the Berea Grit of the Lower Carboniferous. The most productive wells lie however along the so-called White Oak anticlinal which extends from Wirt Co. West Va. across the Ohio at Marietta and north through Washington Co. having the Macksburg field on the north. The Volcano Field of West Va. is the one best known in that state. The anticlinal axis itself undulates and in the depressions the oil is found. This anticlinal is often called the "oil break". The oil is contained in the Berea Grit, being roofed by the Cuyahoga Shale. These districts were developed about 1865.

The Northwestern Ohio District. In the northern prolongation of the Cincinnati Arch, a very productive oil and gas field has lately been opened up about Findlay and Lima Ohio. The oil comes from the Trenton limestone here forming a flat arch, with gas at the summit, oil next on the flanks and brine further out.
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Ohio. Orton E. Econ. Geol.. Ohio Geol. Survey. Vol. V.& VI. Rec.
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Kentucky and Tennessee Fields. Various districts have produced oil in Ky. but the best known is the Burkesville, along the Cumberland River, in southwestern Ky. and Tenn.. The neighboring town of Glasgow is now the only active producer and the amount is now very small. Its source is from the horizon of the Utica Slates. Oil is also known in other parts of the state.
Kentucky and Tennessee. Lesley J.P. Petroleum of Ky. and Records of Borings in Penn. Proc. Amer. Phil. Soc. Vol. X.73. 33
Popular Fallacies respecting Petroleum. Vol. X. p. 110.
Safford J.M. Note on the Geological position of Petroleum reservoirs in South Ky. and Tenn. A.J.S.II. 42. 104
Shaler N.S. On General Origin from Devonian Shales. Report Ky Survey III. 109

Colorado. Fremont Co. Col. produces considerable oil for local consumption. It comes from the Col. Shales, of the Cretaceous. The wells are near Florence just below Canon City, on the Arkansas River, and on the outskirts of the Canon City Coal region. It yields about 40% illuminating products the remainder being lubricating oils.

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Ihlseng M.C. Ann. Report Col. Sch. of Mines. 1886.
Newberry J.S. The Oil Fields of Col. S.of M.Q. X. Jan. 1889. Rec E.& M.Jour. Dec. 15 1888. p.479.

California. Considerable oil is produced in Ventura and Los Angelos Co's, in the southwestern part of the state. The oil which has been obtained in increasing quantities of late years comes from shales of the Miocene Tertiary. It hardens readily to asphalt, quantities of which occur along the outcrop of the shales.
California. Goodyear W.A. State Mineralogist Report 1887.
Silliman B.Jr. Petroleum in Cal. A.J.S.II. 39. 101
" Exam. of Petroleum from Cal. A.J.S.II. 39. 341
Silliman B. on Naptha and Illuminating Oil from Heavy Cal. Tar. A.J.S.II. 43. 242
" On the Oil Property of the Philadelphia and Cal. Petroleum Co. Separate Print. 1865

Canada. Petroleum also occurs at Enniskillen just northwest of Lake Erie in the Corniferous limestone.
Hunt T.S. On the Geology of Southwestern Ontario. A.J.S.II 46. 355
Reports of Canadian Geological Survey.
Winchell A. Note on the Geol. of Petroleum in Canada West. A.J.S. II. 41. 176.
Mention made of the oil fields of Galicia, Austria and of Baku on the Caspian Sea. (Miocene Tertiary). Maps and Sections of the American localities. It will be remarked that in America we obtain oil from sandstone receptacles, (Penn. and Eastern Ohio) from limestone (Northwestern Ohio and Canada), and from shales(Colorado and California). These points will be referred to again in speaking of the theories of formation after describing Natural Gas.

NATURAL GAS.

Ashburner C.A. The Geology of Natural Gas. M.E. 14. 428.
" The Geological Distribution of Natural Gas in the U.S. M.E. 15. 505 E.& M.J. Jan. 15& 22. 1887. 58. Prelim. Paper. E.& M.J. Nov. 6. 1886. p. 332.
Amer. Man. & Iron World. Dec. 30. 1887. General Review to 1887.
Chance H.M. The Anticlinal Theory of Natural Gas. M.E. 15. 3
Goetz. G.W. Notes on Fuel Gas. M.E. Wash. Meeting Feb. 1890.
Mineral Resources. The Volumes containing all Annual Reviews. Rec. 1887.
Newberry J.S. The Origin of the Carbonaceous Matter in Bituminous Shales. Nat'l Acad. 1883. p. 357.
Orton.E. Dolomitization Idea. Am. Man. and Iron World. Pittsburg Dec. 2. 1887. p.21
" On the Pressure of Natural Gas. Am. Geol. Soc. 1890. 87-98.
White I.C. Anticlinal Theory. Sci. June 26.1885 Petroleum Age for Mar. 1886. A.J.S.III. 31. 393. See also Ashburner, Science July. 1885.

Illinois Geol. Surv. Report Col. Sch. of Mines. 1888.
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Paper. E.& M.J. Nov. 6. 1886. p. 382.
Amer. Man. & Iron World. Dec. 30. 1887. General Review to 1887.
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Foote. G.W. Notes on Fuel Gas. M.E. Wash. Meeting Feb. 1890.
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" On the Pressure of Natural Gas. Am. Geol. Soc. 1890 37-48.
White I.C. Artificial Theory. Sci. June 26.1885 Petroleum Age for Mar. 1886. A.J.S.III. 31. 393. See also Ashburner. Sci. Jan. 1885.

The early oil wells, and the still earlier salt wells often liberated great quantities of gas whose inflammability was known. In a few places it was locally used for illumination and heat. (Fredonia, N.Y.). Its explosive nature and the apparently very great pressure at which it came out militated against its use.

Within the last five or six years it has however been successfully collected, piped long distances, and employed for all the purposes of fuel. It is incomparably the best fuel that has been burned. The search for it has been prosecuted vigorously in many parts of the country and has served to reveal its presence in a number of regions not thought to contain it.

New York. Energetic search has been made in N.Y.. Gas has been found and is now used in the southwestern part of the state in the oil region. Its geological occurrence is similar to the oil referred to above. Smaller amounts have been obtained near Buffalo from the Salina; in Ontario Co. from the Marcellus; and near Oswego from the Trenton.

Ashburner C.A. Petroleum and Natural Gas in N.Y. M.E. 16. 906.
" Geology of Buffalo as related to Natural Gas Explorations along the Niagara River. M.E. 17. 398.
Williams H.S. Geology of Southwest N.Y.. Petroleum Age Bradford Penn. 1887. p. 1642

Pennsylvania. The chief productive regions are in the neighborhood of Pittsburg to which the gas is piped. The wells are located along the Alleghany River, and further north on the outskirts of the oil fields. Also to the southwest in Washington Co..

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Orton E. Preliminary Report Columbus 1887.
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Indiana. Much gas has also been obtained from the region about Kokomo, Noblesville, and Muncie Ind. from the Trenton.

Gorby 15th Annual Report Ind. Geological Survey.
Phinney Natural Gas in Ind. Amer. Man. & Iron World Aug. 1887

The early oil wells, and the still earlier salt wells often liberated great quantities of gas whose inflammability was known. In a few places it was locally used for illumination and heat. (Fredonia, N.Y.). Its explosive nature and the apparently very great pressure at which it came out militated against its use.

Within the last five or six years it has however been successfully collected, piped long distances, and employed for all the purposes of fuel. It is incomparably the best fuel that has been burned. The search for it has been prosecuted vigorously in many parts of the country and has served to reveal its presence in a number of regions not thought to contain it.

New York. Energetic search has been made in N.Y.. Gas has been found and is now used in the southwestern part of the state in the oil region. Its geological occurrence is similar to the oil referred to above. Smaller amounts have been obtained near Buffalo from the Salina; in Ontario Co. from the Marcellus; and near Oswego from the Trenton.

Ashburner C.A. Petroleum and Natural Gas in N.Y. M.E. 18. 908.

Geology of Buffalo as related to Natural Gas Explorations along the Niagara River. M.E. 17. 398.

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Analyses of Natural Gas.

	CH_4	C_2H_6	N	H	C_2H_4	O	CO_2	CO	H_2S
Penn.(Grapeville)	35.08	28.87	27.87	7.05	0.17	0.16	0.58	0.22	
Ohio (East Liverpool)									
Ohio (Findlay)	92.62		3.61	2.18	0.30	0.34	0.26	0.50	0.20
Ind.(Muncie)	92.67		3.53	2.35	0.25	0.35	0.25	0.45	0.15

These analyses were taken from Orton's Reports, Ashburner's Paper.

The Origin of Petroleum and Natural Gas.

(The Students are referred to Orton's Papers Geol. Ohio Vol VI Chap.II for a clear review and statement to which these notes are largely indebted).

Chemical Theories. Bertholet (1866). By the reaction of water at high temperature carryong CO_2 in solution on the alkalies supposed to exist in a metallic state in the interior of the earth. Mendelejeff (1877). By the reaction of water at high temperature on metallic iron and metallic Carbides supposed to exist in the interior of the earth.

Bertholet. Annales Chem. d Phys. IX 481.
Mendelejeff Revue Scientifique 1877 409.

Organic Theories. In general by the chemical alterations which organic matter undergoes when buried in the rocks. It would seem as if the limestone and shale oils and gas may have resulted from the animal matter buried in them. They have more sulphurous compounds as shown by the analyses quoted above of gas from the Trenton, and have stronger and more disagreeable oders and larger percentages of nitrogen. Recent experiments have shown a close analogy between the products obtained from fish oil (Menhaden) and petroleum.

Engler C. Berichte d chem. Ges. 21. 2188 Am. Chem. Jour. 11. 130
Peckham S.F. 10th Census Vol. X. 69.

For the oil and gas so far obtained from sandstone, an origin from vegetable tissues is more probable and these were doubtless in a lower lying source, so that the sandstones are only the receptacle. The evolved products passed off as indicated in the dämmassion of coal and were collected in the higher lying receptacles.

On the basis of a universal origin of petroleum from organic tissue in limestones, Hunt (1863) has argued its derivation by the decomposition of this tissue in the Calcareous receptacle. Newberry (1859 qnd later) has described the changes of organic matter, probably chiefly of vegetable character in shales, as a spontaneous distillation at low temperatures, and to be continuous, not distinguishing with all desirable sharpness between the chemical processes of decomposition and distillation, but furnishing a conception whose main points have been widely accepted since. S.F.Peckham uses distillation more accurately and refers the oil and gas of Penn. to the heat engendered by the elevation and metamorphism of the Appalachians, (i.e. distructive distillation) acting

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on organic tissue in bituminous shales. As Orton says, however, as there is no metamorphism and comparatively little disturbance in eastern Ohio. Conceiving its formation to be by some such processes as these, the collection and storage remain to be considered. E.B.Andrews of Ohio, developed in 1861 (A.J.S.II, 32, 65) the "Cavity Theory" which conceived of caverous fissures in which were collected gas, oil and salt water in the order of their specific gravities, the lightest on top. The products of the horizon at which the drill penetrated, were first yielded. This was an attempt to account for neighboring gas, oil and water wells and was the explanation most widely accepted until the recent interest in gas.

The general alignment of wells along anticlines had early been noted. From this suggestion and by a series of careful surface levelings and well records I.C.White of W.Va. developed the Anticlinal Theory (Science June 26 1885) now quite generally accepted for many regions. The gas, oil and salt water are thought to collect beneath the anticlinal arch with the gas at the top. A well at the crest would thus yield gas, a little way out on the flanks oil; further out, salt water. Orton showed in 1887 (Amer. Manuf. & Iorn World, Pittsburg Dec. 2. 1887) that analyses of drillings from the Trenton limestone of Ohio indicated a dolomite.

	$CaCO_3$	$MgCO_3$	$Fe_2O_3Al_2O_3$	SiO_2
Unchanged Trenton Limestone	79.30	0.92	7.00	12.00
" " "	82.36	1.67	0.58	12.34
Trenton Limestone. Gas Region	53.50	43.50	1.25	1.70
" " " "	51.78	36.80		

From this the inference is drawn that dolomitization has assisted in making the limestone porous. Orton has also shown that anticlinals are not marked in Ohio but are of a gentle character and that often they are only monoclinal, ("Arrested Anticlines"), but at the crests of those the oil etc. collects. (Econ. Geol. of Ohio Vol. VI.) The same author has also shown that the pressure of the gas is purely hydrostatic. (Bull. of the Geol. Soc. Amer. Vol I. p. 87 Jan. 1895). The recent work of Orton and White constitutes a brilliant chapter in American Geology.

Ozocerite or Mineral Wax. This has generally been described as a natural paraffine belonging chemically to the paraffine series and the result of the inspissation or natural distillation of petroleum under conditions that produced a mineral wax instead of an asphalt. Recently Dr.H.Wurtz has advanced the theory that the ozocerite belongs to the olefine series and that it has resulted from petroleum by a polymeric change. The natural waxes are found in this country in Utah, in the San Pete valley, and occur in sandstones. The quantity is said to be large and is now an important economic product. 130000 lbs. were produced in 1889.

E.& M.Jour. Elaterite or Mineral Wax. July 6. 1882. p.2
" " " Ozocerite or Mineral Wax. Mar. 14. 1885. p.163
" " " Mineral Wax. July 6. 1889. p. 8. Rec.

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" " Ozocerite or Mineral Wax. Mar. 14. 1885. p.189
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Lay W.L. General Occurrence in Europe and America. Trans. N.Y. Acad Sci. Vol. II. 1882. p.43
Newberry J.S. E.& M.Jour. May. 17. 1879 p.349. A.J.S.III. 17. 340
Wurtz H. The Utah Mineral Wax. E.& M.Jour. Feb. 15 1879. p.199
" " The Utah Ceroid Minerals E.& M.J.April 5. 79 p.234 Also March 22. 1879. p.199.
" " The Utah Mineral Waxes. E.& M.Jour. July 3. 1889 p.25.
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Reference may also be made to the diamond and its probable origin in some cases through the action of eruptive rocks on bituminous shale. (the Kentucky peridotite dike described by J.S.Diller)

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Bartlett W.H.C. On Contraction and expansion in Building Stone A.J.S.I. 12. 1832
Cutting H.A. Durability of Building Stones. A.J.S.III. 21. 410
Gillmore Q.A. Rept on the Comparative Strength Sp. Gr. and Ratio of Absorption of Building Stones in the U.S. Official Rept Chief of Engineers 1875 (Von Nostrand).
Greenleaf J.L. Building Stones, Their Properties and Uses. S.of M. Quarterly Vol. I. 27. 52
Hatfield R.G. Tests of Building Stone. Jour. Franklin Inst. Mar.68
Hawes & Merrill 10th Census Vol. X. Especially Recommended.
Henry J. On the Mode of testing Building Materials and an account of the Marbles used in the extension of the U.S.Capitol A.J.S. II. 22. 30.
Hull E. A Treatise on the Building and Ornamental Stones of Great Britain and Foreign Countries A.J.S.III. 5. 234
Hunt T.S. On Porosity of Building Stone. Chem & Geol. Essays p.164
Indiana Geological Report 1878 p.88
Johnson W.R. Comparison of Experiments on Amer. and Foreign Building Stones etc. A.J.S. II. 11.)
Marble and Serpentine in Vt. A.J.S. 35 p.390
Merrill G .P. The Collection of Building and Ornamental Stones in the U.S.Nat'l Museum. Smithsonian Rep't 1885-86 pt II p. 277. 643. Reference to separate Works etc. on p.519. Especially Recommended.
Newberry J.S. Repts and Awards Centennial Judges Group I. Rec.
Orton E. Ohio Geol. Survey Vol. V. p.577. Rec.
Presidents Message 32 Congress 2nd Session 1852
Prime F. Rept D3 Vol.I. 138-143 2nd Geol Survey Penn.
Report of Com. on Ia. Capitol Building Stone. Desmoines 1871.
Rep. of Tests made at the Watertown Arsenal for Phila. Com. 1882
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Orton E. Ohio Geol. Survey Vol. V. p.877. Rec.

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Seely H.M. & Brainard E. The Marble Border of Western New England etc. Middlebury Hist. Soc. Vol. I. PT.I 1885 Rec
Smock J.C. Building Stone in the State of N.Y. Bull. N.Y. State Museum No. 3. 1883. Rec.
Sperr F.W. 10th Census Vol. 10.pp. 38-42 Methods of Working.
Truesdell, Jour. Assoc. Eng. Soc. June 1885. p. 302
Winchell N.H. The Comparative Strength of Minn. & New Eng. Granites A.A.A.S. Minneapolis Meeting 12th Ann. Rep. Minn. Geol. p. 44

A. Massive Rocks and Gneiss.

Occurrence. As irregular masses of indefinite extent, (dikes sheets and bosses); forming the great mass of the Archaean, and as various eruptive outbreaks in all ages. Generally of a gray color sometimes red.

Areas. General description of the Archaean Areas of the U.S.; New England, the Adirondacks, the Eastern Appalachian, Minnesota, Wis. Missouri and Western States.

Orthoclase Rocks (Granites, Syenites, Gneisses). On the Maine Coast there are numerous quarries of granite in the Archaean, mostly "biotite granites" (Dix Island etc). New Hampshire, (The Granite State) affords numerous quarries in the Archaean especially near Concord. The rocks are chiefly biotite, muscovite granite, rarely gneiss and syenite. Vermont has a few quarries of granite chiefly of Upper Silurian Age. Massachusetts. Extensive quarries occur in the eastern and central portions of the state, chiefly of hornblende-granites, (Quincy near Boston is the chief center; The rock is popularly called syenite) and gneiss (Monson); All of Archaean Age. Rhode Island. Extensive quarries of biotite-granite (especially at Westerly) of Archaean Age. Connecticut. The quarries produce gneiss with some granite. (New London, an important center). Granitic rocks are abundant in the Archaean of the Adirondacks and in the Highlands on the Hudson River, but are not extensively quarried. The norite from Keesville affords a fine greenish stone. It is called Au Sable Granite. Some gneiss is quarried near Phila. Pa. Granite and gneiss are quarried in Maryland and Delaware, but not in great quantity. Considerable granite and gneiss are obtained in central Virginia. The granite rocks are also quarried in Minnesota, Missouri and California. The later members of the orthoclase series (rhyolites) are much used in Colorado.

Reference made to the Bay of Fundy red granite; to Scotch granite, also to the aesthetic qualities of granite in general, polish, endurance, fusibility and crushing strength.

The Plagioclase Rocks. (Diorite, Diabase, etc.) are far less used than the orthoclase rocks. They are in general of a dark somber color, finely crystalline, less easily quarried, and are often popularly called black granites. Diabase of Devonian Age is quarried in Maine (near Addison Pt.) a melaphyre of the Archaean, near Boston, and some diabase of Triassic Age in New Jersey, Penn, and Virginia. The rocks are extensively known in the west.

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Reference has been made to the norite of the Adirondacks above.

The schistose members of the metamorphic rocks are locally used for rough masonry and foundations where they occur (New York, Phila, Baltimore) but possess no architectural beauty.

F. The Stratified or Sedimentary Rocks.

Sandstones and Limestones are treated by geographical distribution from east to west. They occur as stratified masses of all geological periods from the Cambrian on.

Areas. General preliminary description fo the geological formation of the country east of the Alleghanies and Ohio. In the New England states but little sandstone is quarried except at Portland Conn. and Longmeadow Mass. where very extensive quarries of Triassic red sandstone (generally called "brown sotne") are operated. Some coarse Sandstone and conglomerate of Lower Silurian Age (?) is obtained near Boston. Very extensive quarries of the Triassic red sandstone are situated near Newark N.J. (Belleville) which chiefly supply New York and vicinity. There are also quarries near Philadelphia in Penn. In New York at Potsdam, and vicinity, the Potsdam sandstone Cambrian System is extensively quarried (remarks on its excellence). The Medina sandstone (Upper Silurian System) from the country south of Lake Ontario is much used (examples on the campus). Devonian sandstone generally more or less argillaceous, are extensively quarried especially in Ulster and Delaware counties. They are especially adapted to flagstones for which they are chiefly used. Local use of Devonian sandstones in the older university buildings referred to. In Penn. Devonian sandstones are somewhat quarried especially in Wyoming Co. alike for flagging and building. The principal sandstone in the western prqtion of Penn. are from the Carboniferous and Sub-carboniferous strata. They are generally coarse in texture and adapted only to local use. The same is true of West Va. In the States to the south, but little sandstone is quarried. Mention made of the Florida shell sandstone or "Coquina".

General preliminary description of the geological formation of the country between the Alleghanies and the Mississippi.

The Ohio sandstones are chiefly of Sub-carboniferous Age, and are very extensively quarried in the northwestern portion of the state. (Berea, Euclid, Amherst, etc.) whence they are shipped far and near. The Carboniferous sandstones further south are also extensively used for ordinary constructions. Small amounts of Carboniferous and Sub-carboniferous sandstones are quarried in Ind., Ill., Wisconsin, Iowa, Mo., and Kan., but almost entirely for local consumption. The Cambrian of Lake Superior supplies the Portage stone. The Lower Silurian furnishes considerable in Minn. Further west and south the quarry industry is not as yet much developed or else the chief stone is limestone to be subsequently referred to. The red quartzite of Sioux Falls, Dak. which takes a polish like jasper deserves mention. A warm red sandstone is being

Reference has been made to the marbles of the Adirondacks above.

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7. The Stratified or Sedimentary Rocks.

Sandstones and limestones are treated by geographical distribution from east to west. They occur as stratified masses of all geological periods from the Cambrian on.

Areas. General preliminary description to the geological formation of the country east of the Alleghanies and Ohio. In the New England states but little sandstone is quarried except at Portland Conn. and Longmeadow Mass. where very extensive quarries of Triassic red sandstone (generally called "brown sotne") are operated. Some coarse Cambrians and conglomerate of Lower Silurian Age (?) is obtained near Boston. Very extensive quarries of Triassic red sandstone are situated near Hoverk N.J. (Bellevilla) which chiefly supply New York and vicinity. There are also quarries near Philadelphia in Penn. In New York at Potsdam, and vicinity, the Potsdam sandstone Cambrian System is extensively quarried (remarks on its exposition). The Medina sandstone (Upper Silurian System) from the country south of Lake Ontario is much used (examples on the campus). Devonian sandstone generally more or less argillaceous, are extensively quarried especially in Ulster and Delaware counties. They are especially adapted to flagstones for which they are chiefly used. Local use of Devonian sandstone in the older university buildings referred to. In Penn. Devonian sandstone are somewhat quarried especially in Wyoming Co. altho for flagging and building. The principal sandstone in the western portion of Penn. are from the Carboniferous and Sub-carboniferous strata. They are generally coarse in texture and adapted only to local use. The same is true of West Va. In the States to the south, but little sandstone is quarried. Mention made of the Florida shell sandstone or "Coquina".

General preliminary description of the geological formation of the country between the Alleghannies and the Mississippi.

The Ohio sandstones are chiefly of Sub-carboniferous Age, and are very extensively quarried in the northwestern portion of the state. (Berea, Euclid, Amherst, etc.) whence they are shipped far and near. The Carboniferous sandstones further south are also extensively used for ordinary constructions. Small amounts of Carboniferous and Sub-carboniferous sandstones are quarried in Ind., Ill., Wisconsin, Iowa, Mo., and Kan., but almost entirely for local consumption. The Cambrian of Lake Superior supplies the Portage stone. The Lower Silurian Trenton sandstone is much further west and south the quarry industry is not as yet much developed or else the chief stone is limestone to be subsequently referred to. The red quartzite of Sioux Falls, Dak. which takes a polish like Jasper deserves mention. A warm red sandstone is being

quarried in western Col. along Frying Pan Creek which makes a very handsome stone and on the eastern slope of the mountains are numbers of places which furnish Denver and other places with materials.

CLAYS.

Koenig G.A. Ency. Amer. Supp. to Ency. Brit. Vol. II. p.127. Rec.
Colorado, Col. Clay Manufactures. Mining Industry Denver Jan 24 90P3
New Jersey Rep. on the Clay Dep. of Woodbridge, South Amboy, and other places in N.J. together with their use for fire-brick pottery etc. N.J.Geol. Survey 1877. 382 ff.
Newberry J.S. On the Raritan Clays N.J. A.A.A.S. 1869.
Smock J.C. E.& M.Jour Mch. 23. 6878 p.200/ also Mch. 16 1878 p.185. Geol. Report on Clay Deposits 1878. Mining Clay Trans. Inst. M.E, Vol. III. p.211. Fire Clays. Plastic Clays etc. of N.J, Trans. Inst. M.E. VI, 177. Potters Clay, A.J.S. II. 198.
Ohio Clay and Kaolin Ohio Geol. Rept. Vol. V. p.643.
Penn. Heilprin A, Chapter on Philadelphia Brick etc. in Town Geology 1885.
Penn. 2nd. Survey 1879 McCreaths Report.
Wisconsin, Sweet E.T. Analyses of Milwaukee Clay and Milwaukee Brick Clay A.J.S. (3) Vol. 24. (124) p.134.

Clay consists of the finest particles resulting from the erosion of rocks. They are essentially the hydrated silicate of alumina (kaolin when pure) generally with smaller amounts of SiO_2 as fine quartz grains, of Fe_2O_3, CaO, K_2O and Na_2O. The feldspars of the massive rocks by the loss of their alkalies furnish the necessary hydrated silicate of alumina. Fire Clays lack the iron lime, potash and soda. Brick clays are higher in iron and hence color on burning. The infusible property of fire clay is due to its freedom from these four elements.

Occurrence and Areas. Clay beds occur quite generally throughout the series of stratified rocks but in the older are indurated to slates or less metamorphosed aggregates. Fire clays are especially obtained from the Carboniferous (Cheltenham near St Louis, and in various places in Penn. Ohio and other iron manufacturing districts). Clays of all varieties come from the Cretaceous (Perth Amboy and vicinity N.J.). Cretaceous clays are also wrought at Golden Col. Within the limits of the glacial drift are abundant glacial clays especially throughout New England, (Champlain Stage) of comparatively recent geological origin. These clays of whatever age furnish the material for local brick industries. They are generally in well marked strata, often, unless weathered into a solid mass exhibiting thin beds. (New England clay, Haverstraw N.Y. etc.).

CLAYS.

Clays. Amer. Supp. to Mney. Brit. Vol. II. p.127. Roe.
Colorado. Clay Manufactures. Mining Industry Denver Jan 24 1920
Jersey Rep. on the Clay Dep. of Woodbridge, South Amboy, and
other places in N.J. together with their use for fire-
brick pottery etc. N.J.Geol. Survey 1877. 382 pp.
Newberry J.S. On the Raritan Clays N.J. A.A.A.S. 1888.
Smock J.C. E.M. Trans Meh. 23. 1878 p.200\ also Meh. Is 1878
p.188. Geol. Report on Clay Deposits 1878. Mining Clay
Trans. Inst. M.E. Vol. III. p.311. Fire Clays. Plastic
Clays etc. of N.J. Trans. Inst. M.E. VI. 177. Potters
Clay. A.I.S. II. 100.
Ohio Clay and Kaolin Ohio Geol. Rept. Vol. V. p.643.
Orton. Halfpenn A. Chapter on Philadelphia Brick etc. in Town Geol -
ogy 1883.
Penn. Bnd. Survey 1879 Mcgroaths Report.
Wisconsin Sweet E.T. Analyses of Milwaukee Clay and Milwaukee Brick
Clay A.I.S. (2) Vol. 24. (1884) p.134.

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f comparatively recent geological origin. These clays of whatever
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enerally in well marked strata, often, unless washered into a
olid mass exhibiting thin beds. (New England clay, Beverstraw N.Y.
te.).

	Combined H_2O	SiO_2	Al_2O_3	Quartz	K_2O	Na_2O	CaO	Fe_2O_3
Pure Kaolin	13.9	46.3	39.8					
N.J. Fire Clay	13.2	42.94	40.20	0.51	0.41	0.08	0.10	0.51
Ohio " "	11.68	35.39	31.84	17.13	0.59		0.50	0.67
Missouri "	11.30	38.10	31.52	12.90	0.40			1.92
Colorado "								
N.J. Red Brick Clay	11.80	25.50	17.70	31.80	1.54		0.16	6.40

The oxide of titanium is very generally present in fire clays. Reference made to chalk as a fine lime sediment, and to diatomaceous earth formed of the remains of microscopic organisms, valuable as a polishing agent.

LIMESTONE.

The limestones form stratified masses in all geological systems from the Archaean on.

Areas. (Recall the geological descriptions given under sandstones). The New England states do not furnish much limestone strictly so-called, marble excepted. (see marble later). In New York the limestones of the Lower Silurian, Upper Silurian and Devonian are quite extensively quarried for local use through the interior of the state. (marble not included). Considerable limestone of Lower Silurian Age is quarried in south western Penn.

Unimportant quarries of limestone occur in Maryland, Virginia and other Southern States. In eastern Tennessee, many limestones of Lower Silurian Age (called in the trade marbles) of wonderful variety and beauty are quarried. (Knoxville and Rogersville are the chief centers). In Kentucky near Louisville and Covington are extensive quarries of the Lower Silurian and Sub-carboniferous Systems. In Ohio are very extensive quarries in the Devonian, Upper Silurian (Niagara, Helderberg Stages) Lower Silurian (Cincinnati Stage) in the northern and western portions of the state.

In Indiana, the Upper Silurian and Sub-carboniferous limestones are the basis of a very considerable quarry industry. From the latter comes the famous Bedford stone or Indiana limestone which consists of fossil fragments, and which is shipped all over the eastern U.S. and is one of the principal ornamental stones of Chicago. In Illinois the Upper Silurian and Sub-carboniferous limestones are extensively used for local purposes. In Wisconsin the Lower Silurian and Upper Silurian strata in the southern portions of the state furnish extensive amounts. In Minnesota the Lower Silurian is the source of the limestone and affords a variety of building stones, (the Mankato one of the best known). In Iowa almost all the Series of the Palaeozoic furnish limestones for local use and are much quarried. In Missouri the Sub-carboniferous limestones near St Louis and the Carboniferous near Kansas City furnish much to each of these cities. In Kansas the Carboniferous is the source of the limestone employed for local use. In the other western and southern states the industry is not as yet extensively developed.

Rock material is appointed to 7 different purp

1 Construction

2 Ornament

3 Paving & Flagging

4 Road making

5 Roofing

6 Grinding

7 Fire resisting

int[illegible] about a stone for construction purposes

may be limited by as follows;

Cost

Strength

Texture

Staining

Durability

Easy

Cutting resistances

ranulated vary from 12 to 25 lbs to sq. in. to about 20

udrangular at 1,000 lbs

Pagatine 9,000 to 20,000

ne stone 13,730 to 15,560

rage rock 22,267

x Island Limestone 24,000

Lime Stone 29,333

ing 6,000 to 10,000

Stone (Ohio) 5,000 to 8,000

heat

Slates, Marbles and Serpentines.

Vermont Slate. Eng. & Mining Journal. Vol. IX. No. 19. May 10. 1870
" Manuf. & Builder p.83 about 1870 (Reference for year only approximate)
" Seely H.M.& Brainard E. The Marble Border of Western New England etc. Middlebury Hist. Soc. Vol I Pt.I 1835 Rec.
New York Smock J.C. Building Stone in the State of N.Y. Bull. N.Y State Museum No. 3. 1888 Rec.
Penn. Slate. Penn 2nd Geol. Survey Report D.
" Engineering News Jan 31 1885. p.67

Brief description of the origin of these from sedimentary or stratified beds of similar composition.

Areas. Slate. Western Vermont (Cambrian Period). Eastern Penn (Lower Silurian Period). and less important regions in N.Y., N.J., and Ga..

Somewhat detailed description of the Vermont and Penn. Areas. Marble is obtained in large quantities from aregion in western New England bordering on the N.Y. line. It is considered metamorphosed Lower Silurian limes-tone, an obscure point not yet fully cleared. Rutland Vt., Sheffield and Lee Mass are the chief centers.

In southeastern N.Y. is an extension of the above. Tuckahoe and Pleasantville are the chief centers. Marble also in the northern central portion of N.Y. in St. Lawrence Co.. The majority of the other so-called marbles are strictly speaking limestones. More especially the Tennessee marble referred to under limestones. J.S.Newberry has reported beautifulmarble from western Colorado.

Serpentine is somewhat quarried near New York City, and near Philadelphia. Small amounts are used as an ornamental stone.

Appendix. Building Stones are treated from almost every possible point of view in Vol.X of the Tenth Census. The student is also referred to the Monograph by G.P.Merrill cited above from the Smithsonian Reports and it will be found the best reference book yet published. For resistance to crushing the student is referred to the various engineering treatises and papers mentioned above.

In general it may be said that the chief source of weakness or decay is either some constituent mineral especially liable to alteration, such as pyrites, or the weakning of the cementing material of the individual grains.

On Flagstone see New York Times. Vol. XXI. No. 6342 2nd page. On the decay of Building stone in New York City. Trans. N.Y. Acad. Sci. Vol. II. p.67 and 120. Paper by AA Julien. Also additional later ones by Dr Elliot. On Stone Cutting, Sch. of Mines Quarterly Vol. IV. p.265., Paper by Prof Trowbridge.

WATER.

Chamberlain T.C. The requisite and qualifying conditions of Artesian wells. 5th Ann. Report Director U.S.G.S.
Hunt T.S. Contributions to the Chemistry of Natural Waters A.J.S. II. 40. 43. also 193

Slates, Marbles and Serpentines.

Vermont Slate. Eng. & Mining Journal, Vol. XX. No. 19. May 10. 1870

" Manuf. & Builder p.85 about 1870 (Reference for year only approximate)

" Seely H.M.& Brainard E. The Marble Border of Western New England etc. Middlebury Hist. Soc. Vol I Pt.I 1885 Rec.

New York Smock J.C. Building Stone in the State of N.Y. Bull. N.Y State Museum No. 3. 1888 Rec.

Penn. Slate.Penn 2nd Geol. Survey Report D.

" Engineering News Jan 31 1885. p.87

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On the decay of Building stone in New York City. Trans. N.Y. Acad. Sci. Vol. II. p.67 and 1880. Paper by AA Julien. Also additional later ones by Dr Hillot. On Stone Cutting, Bull. of Mines Quarterly Vol. IV. p.265, Paper by Prof Trowbridge.

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Hunt T.S. Contributions to the Chemistry of Natural Waters A.J.S. II. 40. 43. also 193

hunt A.E.& Clapp G.H. The impurities of Water M.E. 17. 338.
Any good geology, Geikie and Dana especially recommended chapters on water. Numerous and instructive analyses in Justus Roths Allgemeine und Chemische Geologie. Band I.

Water is the universal solvent and erosive agent, gathering mineral matter in solution while percolating through the rocks.

This action is added by CO_2 in solution. The chief elements affected are calcium, magnesium, iron, potassium and sodium.

The common salts are carbonates, sulphates and chlorides. Organic matter is frequently present as well. Limestone regions are prone to have hard waters, granites, slates and sandstones afford the purest. Lakes with no outlet (as the Great Salt Lake and others of the Great Basin) become strong brines.

Analyses of Various Waters.

Rain	Delaware River in 10000 pts Water.		Ocean Average.	Great Salt Lake.	Syracuse Brines.	Mich. Brines (Saginaw).	Rock Salt Warsaw N.Y.
0.3376	$CaCo_3$ 0.223	Water	96.5	85.0060	83.5747	78.6799	1.5
N.6447	$MgCO_3$ 0.152	NaCl	2.665	11.862	15.5317	17.5103	96.493
CO 1.77	K_2SO_4 0.032	$MgCl_2$	0.315	1.4908	0.14441	1.0685	0.298
	NaCl 0.018	KCl	0.140	0.0862	0.0119		
	K.Cl.0.002	$Ca\ SO_4$	0.175	0.0858	0.5772	0.0983	1.464
	SiO_2 0.085	$MgSO_4$	0.216	0.9321			
	K_2CO_3 0.029	NaBr	0.035				
	Fe_2C_3 0.005	K_2SO_4		0.5363			
		CaCl			0.1533	2.6430	0.136
		MgBr			0.0024		
		$FeCO_3$			0.0044		Insol- 0.104

Remarks on its connection with general health, and steaming purposes

Artesian Wells. The necessary condition for success is the existence of a basin with a porous or permeable stratum between two impervious layers. Views to illustrate.

Remarks on the success of artesian wells in regions of bad water Denver Colorado cited.

BRINES AND SALT DEPOSITS.

General. Gaessmann C.A. Contributions to the Chemistry of Common Salt With particular reference to our home resources. A.J.S. II. 49. 1878. Rec.

Hunt T.S. On the Extraction of Salt from Sea Water. A.J.S. II. 35. 361.

Mineral Resources. 1882, 83, 84, 85, 86, of U.S. Geol. Survey Each contains a good Resume.

Winchells Geol. Studies p.186 Popular account of Salt.

10th Census Vol. II. on Manufactures, contains important Statistics.

Analyses of Various Waters.

Rain Water.	Delaware River in 10000 pts	Ocean	Great Salt Lake.	Springs Average,	Mich. Brines,	Rock Salt Brines (Saginaw).	Warsaw N.Y.
0.8376	CaO_3 0.283	Water	96.5	85.0080	83.5747	78.0799	1.3
N.6447	$MgOO_3$ 0.182	NaCl	2.665	11.882	15.8817	17.8108	98.798
00 1.77	K_2SO_4 0.032	$MgCl_2$	0.318	1.4908	0.14441	1.0885	0.298
	NaCl 0.018	KCl	0.140	0.0882		0.0113	
	K_2Cl_2 0.008	Ca	SO_4 0.178	0.0882	0.5772	0.0823	1.464
	SiO_2 0.085	$MgSO_4$	0.218	0.3321			
	K_2CO_3 0.029	NaBr	0.035				
	Fe_2O_3 0.008	K_2SO_4		0.3343			
		CaCl			0.1833	2.6130	0.136
		MgBr			0.0024		
		FeCO			0.0044		Insol-
							0.104

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GENERAL REPORT DEPOSITS.

General. Gassmann C.A. Contributions to the Chemistry of Common Salt With particular reference to our home resources. A.J.S. II. 49. 1870. Rec.

Mack T.S. On the Extraction of Salt from Sea Water. A.J.S. II. 36. 361.

Mineral Resources. 1882, 83-84, 85, 86, of U.S. Geol. Survey.

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Winchells Geol. Studies p.188 Popular account of Salt.

10th Census Vol. II. on Manufactures, contains important Statistics.

Canada. Gibson John. On the Salt Deposits of W. Ontario A J.S. III 5 36
Hunt T.S. The Goderich Salt District Ontario M.E. 5. 533
Heinrich O.J. The Manhattan Salt Mine Goderich Can. M.E. 125
See also Geological Survey Canada 1867-69
Kansas. Hay-Robert Notes on a Kansas Salt Mine Feb. 90 p. 65 A. Geol.
Louisiana. Petite Anse Mine E.& M. Jour Oct. 6th 1883. p. 280
Vermillion Rock Salt at Petite Anse La. A.J.S. II. 36. 308.
Goessmann C.A. On the Rock Salt Deposits of Petite Anse La. Am. Bureau of Mines. Also A.J.S. II. 43. 284.
Hilgard E.W. On the Geol. of the Miss. Delta and the Salt Dep. of Petite Anse. A.A.A.S. 17th Meeting. Published in Abstract in A.J.S. II. 47. 77.
Owen R. On the Deposit of Rock Salt at New Iberia La. Trans. St Louis Acad. Sci. II. 250. A.J.S. II. 42. 120
Pomeroy. R.A. The Petite Anse Salt Mine. M.E. 17. 107.
Michigan Winchell A. On the Saliferous Rocks and Salt Springs of Mich. A.J.S. II. 34. 307
Geol. Survey of Mich. Vol. III. 1873-76 App. B. p. 171
New York. Salt Deposits of N.Y. E.& M.J. Feb. 9. 1889 133
N.Y. State Assembly Documents Vol. 3. No. 35 (1883) P. 17 Vol 5. No. 34 Rec.
Forman J. Remarks upon the Salt Formation of Salina N.Y. and other Places A.J.S. I/ 19. 141
Goessmann C.A. Rept on the Brines of Onondaga, Syracuse Dec 62. Rept on the Manufacture of Solar Salt from them do. De 63. Contributions to the Chemistry of the Mineral Springs of Onondaga N.Y. A.J.S. II. 42. 211. 368.
Contributions to the Chemistry of Brines A.J/S. II. 44. 77
MacFarlane J. Discovery of Rock Salt at Wyo. in western N.Y. Syracuse Journal June 29. 1878
Pennsylvania. Stieren Edw. Observations on the Salt Waters of the Alleghany & Keskonnistas Valleys A.J.S. II. 34. 46
Virginia Hayden C.B. On the Rock Salt and Salines of the Holston. A.J.S. 44. 173
Rogers H.D. Rept on the Salt and Gypsum of the Preston Salt Valley & Holston River Va. Preston 1854. A.J.S. II. 18. 273

Brines are obtained either from the ancient sea water which still soaks porous strata (see under Petroleum) or from stores formed by the leaching of beds of rock salt which have resulted from the drying up of ancient isolated branches of the sea or salt lakes.

Salt producing areas. Syracuse N.Y. The brines are pumped from wells 360 to 420 feet deep which penetrate to an ancient river channel now filled with gravel. Waters soaking through the neighboring salt bearing strata of the Salina Period (Upper Silurian) collect in the natural recepticals and are pumped out. Extensive beds of rock salt are now known to exist under the surface of central N.Y. in the Salina strata. It is mined in Wyoming

Canada. Gibson John, On the Salt Deposits of W. Ontario A.J.S. III 5:36
Hunt T.S. The Goderich Salt District Ontario M.T.S. 533
Heinrich O.J. The Manistean Salt Mine Goderich Can. M.M. 125
See also Geological Survey Canada 1857-69
Kansas. Hay-Robert Notes on a Kansas Salt Mine Feb. 20 p. 65 A. Geol.
Louisiana. Petite Anse Mine E. & M. Journ Oct. 8th 1859. p. 280
Vermilion Rock Salt at Petite Anse La. A.J.S. II. 36. 308
Goessmann C.A. On the Rock Salt Deposits of Petite Anse La.
Am. Bureau of Mines. Also A.J.S.II. 48. 284.
Hilgard E.W. On the Geol. of the Mines, Salts and the Salt
Dep. of Petite Anse. A.A.A.S. 17th Meeting. Published in
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Pomeroy R.A. The Petite Anse Salt Mine. M.M. 17. 107.
Michigan Winchell A. On the Salt-ferous Rocks and Salt Springs of
Mich. A.J.S. II. 34. 307
Geol. Survey of Mich. Vol. III. 1878-76 App. B. p. 171
New York. Salt Deposits of N.Y. E.& M.J. Feb. 8. 1889 133
N.Y. State Assembly Documents Vol. 8. No. 88 (1888) p. 17 Vol 8.
No. 88 Doc.
Forman J. Remarks upon the Salt Formation of Salina N.Y. and
other Places A.J.S. I 19. 141
Goessmann C.A. Rept on the Brines of Onondaga, Syracuse Deep
62. Rept on the Manufacture of Solar Salt from them do. Do
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Contributions to the Chemistry of Brines A.J.S.II. 44.77
MacFarlane J. Discovery of Rock Salt at Wyo. in western N.Y.
Syracuse Journal June 29. 1878
Pennsylvania. Stevenson Rev. Observations on the Salt Waters of the
Allegheny & Kanawha Valleys A.J.S. II. 34. 48
Virginia Hayden G.B. On the Rock Salt and Salines of the Holston.
A.J.S. 44. 173
Rogers H.D. Rept on the Salt and Gypsum of the Preston Salt
Valley & Holston River Va. Preston 1884. A.J.S.II. 18.273
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Extensive beds of rock salt are now known to exist under the sur-
face of central N.Y. in the Salina strata. It is mined in Wyoming

Co. (Warsaw). A total thickness of about 250 ft. was found in the Ithaca Gas Well in several beds between 2000 and 2600 ft. below the surface. Rock salt is generally interbedded in shales and gypseous strata. Ohio brines are obtained from the Lower Carboniferous strata (Berea Grit). Michigan brines come from Carboniferous strata Others are obtained in less amounts for local consumption in West Va., Virginia (from Triassic strata). Dakota Kansas and elsewhere.

So-called salt licks or springs are not uncommon throughout the country. Rock salt is known in very extensive amount and is now mined at Petite Anse La., (of Quaternary Age). Salt is obtained from many drying or dried lakes in Cal., Arizona, Nevada, and other western States. Mich. produces the most salt, N.Y. second Ohio third. Remarks on the analogous Borax deposits of California.

Views of geological sections and to show geographical distribution.

California. Hanks H.G. Report of Cal. Mineralogist 1883 part II Rec.
Whitney J.D. On Borax in Cal. Geol. of Cal. I.96 A.J.S.II. 41 255.

SOIL.

Any good geology, Geikie and Dana recommended.
Williams S.G. Applied Geology Chap. VI. p.101 In which many additional references will be found.

Soil consists either of decomposed rock in place, or of recent sedimentary deposits. We distinguish (1) Vegetable soil, (2) Subsoil. (3) Undecomposed rock. Remarks on the influence of plants, earth worms and rains and the continual erosive action of the last.

In the northern portion of this country the original decomposed rock is largely scraped away by the glaciers of the Glacial Period. We may trace the southern termination of these on the map through Long Island, New Jersey, northern Penn., northern Ohio, Ind., Ill., and then north westerly. Remarks on glacial drift and recent alluvial deposits in this region. Further south decomposed surface rocks occur to great depths. The character of the soil depends largely on the character of the rocks beneath.

FERTILIZERS.

In the monograph by Penrose cited below an extended bibliography will be found. The other references here given are intended to supplement this list, so far as they concern phosphates.

General. E.& M.Jour. June 8.1878. p.393. Phosphate of Lime.
Bailey J.W. On the Origin of Greensand and its formation in the Ocean of the present Epoch. A.J.S.II. 22.280. 296. Proc.Boston Soc. Nat. Hist. V. 364.
De la Beche. Phosphate of Lime in Greensand and Marl. Geol. Soc. London Proc. May 1849 p.LXXXII. A.J.S.II 8. 422
Mineral Statistics U.S. All the Volumes.
Penrose R.A.F. The Nature and Origin of Deposits of Phosphate of Lime. Contains a Bibliography p.129. Bull. 46 U.S.G.S. Rec.

Co. (Morse). A total thickness of about 250 ft. was found in the Ithaca-Gas Well in several beds between 2000 and 2600 ft. below the surface. Rock salt is generally interbedded in shales and gypseous strata. Ohio brines are obtained from the lower Carboniferous strata (Berea Grit). Michigan brines come from Carboniferous strata. Others are obtained in less amounts for local consumption in West Va., Virginia (from Triassic strata), Dakota, Kansas and elsewhere.

So-called salt licks or springs are not uncommon throughout the country. Rock salt is known in very extensive amount and is now mined at Petite Anse Is., (of Quaternary Age). Salt is obtained from many drying or dried lakes in Cal., Arizona, Nevada, and other western States. Mich. produces the most salt, N.Y. second Ohio third. Remarks on the analogous Boran deposits of California.

Views of geological associations and to allow geographical distribution.

California. Hanks H.G. Report of Cal. Mineralogist 1893 part II Rec. Whitney J.D. On Borax in Cal. Geol. of Cal. I.96 A.J.S.II. 41 238.

SOIL.

Any good geology, Gothic and Dana recommended.

Williams G.G. Applied Geology Chap. VI. p.103 In which many additional references will be found.

Soil consists either of decomposed rock in place, or of recent sedimentary deposits. We distinguish (1) Vegetable soil, (2) Subsoil. (3) Undecomposed rock. Remarks on the influence of plants, earth worms and rains and the continual erosive action of the last.

In the northern portion of this country the original decomposed rock is largely covered away by the glaciers of the Glacial Period. We may trace the southern termination of these on the map through Long Island, New Jersey, northern Penn., northern Ohio, Ind., Ill., and then north westerly. Remarks on glacial drift and recent alluvial deposits in this region. Further south decomposed surface rocks occur to great depths. The character of the soil depends largely on the character of the rocks beneath.

FERTILIZERS.

In this monograph by Penrose cited below and extended bibliography will be found. The other references here given are intended to supplement this list, so far as they concern phosphates.

General. U.S. Ill. Jour. June 8.1878. p.393. Phosphate of Lime.

Bailey J.W. On the Origin of Greensand and its formation in the Ocean of the present Epoch. A.J.S.II. 22.280. 296.

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Penrose R.F. The Nature and Origin of Deposits of Phosphate of Lime. Contains a Bibliography p.129. Bull. 46 U.S.G.S. Roc.

Sharpless S.P. On some rocks and other dredgings from the Gulf Stream A.J.S.III. 1. 168.

Alabama. Smith E.A. In Perry Co. Ala. A.J.S. June 1884. 492

Canada. E.& M.Jour. Feb. 24. '83. P.103. Canadian Apatite.

Broome G. Apatite Deposit of Lawark Co. Ont. Can.A.A.A.S. 1870. Good Account.

Falding F.J. Notes on Canadian Fluor Apatite or phosphate of lime E.& M.Jour Dec.4. '86. p.402 Also probable Origin November 27. p.383

Horsford E.N. Guano the Origin of the Apatite of Rideau Can. A.A.A.S. 1870/

Hunt T.S. Apatite Deposits of Canada E.& M.J Feb.23.84 p.138

" Canadian Apatite E.& M.J. Feb. 1883 p.163

" Apatite Mining in Canada E.& M.Jour Oct. 20 1888

" Future of Phosphates in the U.S. & Canada E.& M.Jour.Jan 26. 1889. & Feb. p. 181

Florida. Ledoux A.R. The Phosphate Beds of Fla. E.& M.J Feb.8.90.17

Robertson F.L. Florida Phosphates. Manufactures Record. Baltimore Jan. 25. 1890 Cor.Exchange Place & Commerce St.

Michigan Mineral Statistics of Mich. 1881& subsequent years on Gypsum.

New Jersey Geological Report N.J. 1868 on Marls and Greensands.

New York. Jackson C.T. On Eupyrchroite of Crown Pt. N.Y. A.J.S. II 12. 73. Also N.Y. Rep. on Mineralogy p.240

Williams S.G. On the N.Y.Gypsum Beds. A.J.S. III.30. 212.

Norway E.& M.Jour. July 2. 81. p.4. On the Occurrence of Apatite in Norway.

South Carolina E.& M.Jour. Oct. 29.81. Mining Phosphate Rocks in South Carolina.

Holmes F.S. The Phosphate Rocks of S.C. Charleston 1870. Noticed in A.J.S.III. 1.221

Shepard C.N. Jr. Note on the Origin of the Phosphatic Formation A.J.S. II. 47. 338.

" Notes on the occurrence and composition of the Nodular Phosphates of S.C. A.J.S.II. 47. 354.

General description of the geological structure of the Atlantic coast especially the Cretaceous, Tertiary and recent sedimentary deposits from New Jersey southward, consisting of sands, clays and inc. oherent shell beds.

Peat. Already described p. 80 called muck in this connection.

Marls. Marls are very calcareous clays. The lime is often present as comminuted shells and thus gives a sandy character to the mass. Phosphoric acid is also high. The so-called "greensands" are similar to marls, but have enough green silicate of iron (glauconite) to color them. Marls are of Cretaceous, Tertiary and Recent geological Age. The Cretaceous are abundant in New Jersey(map and sections shown) and extend to some extent into Del. and Md.. Tertiary marls run through Va., and the states on the

Sharpless S.P. On some rocks and other dredgings from the Gulf Stream A.J.S.,III. I, 1858.

Alabama. Smith E.A. In Perry Co. Ala. A.J.S. June 1884. 428

Canada. E.& M.Jour. Feb. 24, '83. P.108. Canadian Apatite.

Broome G. Apatite Deposit of Lanark Co. Ont. Can.A.A.A.S. 1870. Good Account.

Fielding P.J. Notes on Canadian Minor Apatite or phosphate of lime E.& M.Jour Dec.4, '82. p.402 Also probable Origin November 27. p.383

Horsford E.N. Guano the Origin of the Apatite of Rideau Can. A.A.A.S. 1870\

Hunt T.S. Apatite Deposits of Canada E.& M.J Feb.23.84 p.138

" Canadian Apatite E.& M.J. Feb. 1883 p.183

" Apatite Mining in Canada E.& M.Jour Oct. 20 1888

" Nature of Phosphates in the U.S. & Canada E.& M.Jour.Jan 26. 1889. & Feb. p. 101

Florida. Ledoux A.R. The Phosphate Beds of Fla. E.& M.J Feb.8.90.17

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Atlantic and the Gulf. These are only dug for local use outside of New Jersey. Recent marls are found under peat bogs and in the bottoms of dried up ponds and lakes.

Gypsum is the hydrated sulphate of calcium $CaSO_4 \cdot 2H_2O$. It contains more or less earthy matter as quarried. Its general occurrence associated with rock salt commented on, (See Salt), in New York in the Salina; in Mich. Subcarboniferous; Ohio, Helderberg or Waterlime; known, and to a smaller extent utilized in Va., Ala., La., Tex., Ark., Kan., and the west. Ohio and Mich. manufacture by far the greater part of the gypsum or plaster at Sandusky, and Grand Rapids. Quarries on Cayuga Lake at Union Springs noted and described .

Phosphates. The mineral Apatite ($3CaO.P_2O_5 \cdot Ca(Cl_2F_2)$) in the Archaean, and beds of fossil bones, phosphatic nodules, etc. of Tertiary Age, are the principal commercial sources of phosphates. The latter are found in North and South Carolina along the seaboard and in Florida (recently discovered).

Apatite occurs in moderate amounts in the Archaean rocks at Bolton, Mass. and Crown Point, N.Y. but is not commercially abundant. It is mined however at Burgess and Elmsley in the S.E. portion of Ontario, Can., north of the Thousand I's, and in Quebec along the Ottawa River. The mineral occurs in veins and pockets associated with calcite, feldspar, mica, pyrite, sphene, zircon and pyroxene in metamorphic rocks, gneiss, quartzite and crystalline limestone. It is often in crystals which at times attain great size and are always curiously rounded, and again in crystalline masses. It has been variously thought eruptive or intrusive, segregated and organic in origin. (Maps, sections and specimens).

The Phosphates of North and South Carolina are beds of fossil bones etc., or the nodular layers which have resulted from the re-dissolving of such original beds. They form at times strata of some regularity but also occur as scattered nodules in marl beds. They are mined and dredged from river bottoms. They afford from 28-50% phosphate of lime. Beaufort and Charleston S.C. are the chief centers. In 1885 nearly 400,000 long tons were produced.

Cf. especially Mineral Resources U.S. 1883-84 p. 783 for valuable descriptions analyses, and statistics.
Specimens exhibited and views of geographical distribution.

Abrasives.

In general the volumes of the Mineral Resources of the U.S. contain the most accessible literature. See especially Vol. for 1886 Safford J.H. Grindstones etc. Centennial Exposition Reposts and Awards Group I.

The rock materials used in grinding etc. are buhrstones or millstones, grindstones, novaculite and whetstones, corundum and emery, and infusorial earth for fine polishing.

The buhrstone or millstone is a fine quartzite or sandstone which does not glaze nor yet rub off too easily. The principal

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The burrstone or millstone is a fine quartzite or grindstone which does not glaze nor rub off too easily. The principal

sources are the so-called Esopus Stone from Ulster Co. N.Y. the Cocalico from Lancaster Co. Penn. and one from North Carolina.

All these are used for grinding drugs, paints etc. as steel rolls are now mostly used for grain.

Grindstones are made of gritty and firm sandstones and are of various qualities and grades. The Lower Carboniferous Series of Ohio and Mich. (See also under building stone) furnish the greater portion, and smaller amounts are imported. In 1887 40000 tons were produced.

Orton E. Reports on the Econ. Geol. of Ohio, Vol's V & VI.

The small whetstones are made from the novaculite of Ark. which comes from several counties near Hot Springs, and from a grity schist in northern N.H. and Vt.. The grit is chiefly due to small angular quartz crystals, and in the New England stone to garnet and rutile as well. A fine grained sandstone from Cortland Co. N.Y. just north of us also affords considerable amounts known as "Labrador" stone, and Indiana furnishes two brands called Hindostan and Orange.

Sutton J.J. Washita and Arkansas Oilstones and Quarries. E.& M.Jour October 12 1889.

Corundum (Emery).

Smith J.L. On the Geology of Emery and Corundum A.A.A.S. 6.274

Asia Minor. Emery Mines of Asia Minor. E.& M.Jour. June 5,'86 p.410

Report of Consul Stevens of Smyrna.

Smith J.L. Emery formation of Asia Minor. A.J.S. II. 7.283.

List of Minerals with A.J.S. II. 9. 239. Not important.

Memoir on Emery. Pt.I. Geol. &. Min. of Emery from observations made in Asia Minor. A.J.S.II. 10. 354. Pt. II. On the Minerals Associated with Emery. A.J.S. II. 11. 53

Mass. Jackson C.T. On the Discovery of Emery at Chester Mass. A.J.S. II, 39. 1887.

Chemical Anals. of Minerals associated with Emery of Chester Mass. Andesine, Diaspore, Margarite, Clinochlore, & Chlorite, Bost. Soc. N.H. Vol. 10 p. 321. 1864-66

Shepard C.U. Corundum & Associates at Chester Mass. A.J.S. II. 40. 110. 7,123. Unimportant, 2nd ref. says Emery from associated Talc rock.

Smith J.L. On the Emery Mine of Chester Hampden Co. Mass. with remarks on the nature of Emery & its associates Minerals A.J.S. III. 42.p. 33.

Jackson C.T. Analyses of some Minerals from the Emery Mine Chester Mass A.J.S. II . 42. 107

New York. Williams G.H. Norites of the Cortland Series on the Hudson River near Peekskill N.Y. A.J. S. III. 33. 191. '87

North Carolina E.& M.Jour July 21. 88. 46 Gneiss-Dunite Contacts Corundum Hill N.C.

Genth F.A. Corundum its Alterations and associates Minerals Proc. Am. Phil. Soc. Sept. 19. 73. A.J.S.III. 6. 461.

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North Carolina. Jenks C.W. Corundum and its Gems. E.& M.J. Nov. 2. 1878 p. 311/ Rec.

Kerr W.C. Geology N.C. 1875.

Raymond R.W. Jenks Corumdum Mine Macon Co. N.C. M.E. 7. '83 Corundum in five beds of chlorite or dunite. This is the Mine near Franklin N.C. game as Culsager Mine .

Shepard C.U. Sr. On the Corundum Region of N.C. & Ga. with description Etc. A.J.S. III. 4. 109. 175. 170 miles long 10 miles bread, in chrysolite rock.

Smith J.L Notes on the Corundum of N .C. Ga. & Mont. with a description of the Gem Variety of the Corundum from these localities. A.J.S. III. 6. 130. Rec.

Corundum is crystallized Al_2O_3 and is the mineral of hardness 9, in the common scale. The varieties with vitreous luster and light colors are called sapphire, the duller, more smoky colors, still of vitreous luster, corundum, and the variety mixed with more or less magnetite, hematite, spinel etc. and appearing like a powdered iron ore is called emery. These varieties are the common abrading agents when great hardness is required.

Corundum or emery is found in the U.S. at Chester Mass., near Peekskill N.Y., and in N.C., and Ga.. At Chester it occurs as a bed or vein in gneiss near its contact with mica schist and is quite persistent for a considerable distance. Much talc in the pinched portions of the vein, and the usual minerals, margarite, corundophilite, diaspore etc. are found associated with it.

Of late years it has been less productive than formerly. The corundum near Peekskill occurs as a contact phenomenon associated with the eruptive rocks of the Cortland series and the neighboring schists. The material mined consists chiefly of a mixture of the spinel, hercynite?, corundum, garnet and magnetite and is now no longer produced.

North Carolina and Georgia are the most productive of the Amer. localities. The corundum occurs in the dunite or olivine rock that forms a belt in the western portion of these states. At the Jenks (or Culsagee) Mine the corundum is found in five beds of chlorite that traverse the great dike or mass of dunite. Many beautiful minerals come from the mines and neighborhood and numerous interesting paramorphs of corundum to various other species have been described by Dr Genth. Corundum has been reported as an interesting mineral from various other portions of the country, notably from Chester Co. Penn. but as actual producers none have figured as largely as the localities specified.

The researches of Dr. J. Laurence Smith of Louisville, while in the employ of the Turkish Government in Asia Minor and the Grecian Archipelago about 1846 added vastly to our knowledge of the occurrence and associates of corundum. In the Levant it occurs invariably in limestone or on the weathered outcrop, and near associated schists and gneisses. The regions are highly metamorphic.

North Carolina. Jenks C.W. Corundum and its Gems. E.& M.J. Nov. 2.
1878 p. 311\ Roe.
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Much of the product comes to this country. In 1886 the N.C. and Ga. mines produced 645 short tons worth $116,190.00. Infusorial earth is a common polishing agent for fine work and is obtained mostly from Maryland on the Patuxent River. Other deposits are known in N.J., in N.M. and on the Pacific. It is a common thing on the bottoms of ponds and lakes, and is left by their drying up.

Mica.

New England Shaler N.S. Mica Mines of N.E. 10th Census Vol.15.p.833
New York E.& M.Jour. Nov. 24 '83 p.439. Notes on Mica and Asbestus in New York.
North Carolina Kerr W.C. Mica Mines of N.C. M.E. C. 457.
The Mica Veins of N.C. E.& M.Jour. Mar 20,'81. p.211.
Phillips W.B. Mica Mining in N.C. E.& M.Jour April 21'83 p.286 also in following 306. 322. 382. June 2. June 9. 16. 436.
Mineral Resources 1887. And E.& M.Jour Sep. 26. 1885

Although the use of mica is substantially limited to the doors of anthracite stoves, its annual product in later years is valued at $75000- $100,000. Muscovite or less frequently phlogopite supplies the marketable kinds. It is produced in North Carolina and New Hampshire, and to a far less degree in the Black Hills, in New Mexico and elsewhere in the west. N.C. leads with N.H. second. The mica occurs in the south in great, coarsly crystalline granite dikes or veins, more probably the latter, of the segregated type, and the result of aque igneous action. The veins are in gneiss.

The New England mines are said by Prof Shaler to be on beds. The occurrence of great granite veins or dikes in the Black Hills was referred to under Tin. The mica is by no means the largest component of the vein, but is in scattered bunches, mingled with quartz, feldspar and a variety of minerals. These same veins occur within the city limits of New York and recently some fine large plates have been obtained.

Barite.

Mineral Resources all the volumes.

Barite valued at $30-40000, is produced annually and used in paints, and for chemical purposes. It comes especially from Missouri and Virginia. In Mo. it occurs in the region south from St. Louis, near but not with the lead mines mentioned under Type 23.

In south west Virginia in the region mentioned under Type 27 other masses of barite are found in veins, and in various parts of the country it is a common vein filling. Chesire Conn. is a well known locality and the gash veins of the Miss. Valley, Type 24 contain it.

Sulphur,

Foreign E.& M.Jour June 16. '83. p.435. Sulphur Mines of the Caucasus.
E.& M.Jour. Aug. 9. 1879. p.89. The Sulphur Dep. in Iceland.
E.& M.Jour. Sep. 1 & 8.'83. p.174.The Sulphur Mines of Sicily.
Higgins N.S. Sulphur Dep. of the Island of Saba, Dutch W.I.
A.J.S. II. 46. 270. Extract from a Report.

Much of the product comes to this country. In 1902 the N.C. and Ga. mines produced 645 short tons worth $116,190.00. Intimately earth is a common polishing agent for fine work and is obtained mostly from Maryland on the Patuxent River. Other deposits are known in N.J., in N.M. and on the Pacific. It is a common thing on the bottoms of ponds and lakes, and is left by their drying up.

Mica.

New England Shaler N.S. Mica Mines of N.E. 10th Census Vol.15.p.833
New York E.& M.Jour. Nov. 24 '00 p.439. Notes on Mica and Asbestus in New York.

North Carolina Kerr W.C. Mica Mines of N.C. M.R. C. 457.
The Mica Veins of N.C. E.& M.Jour. Mar 20.'01. p.211.
Phillips W.B. Mica Mining in N.C. E.& M.Jour Apr.21'00 p.388 also in following 306. 322. 332. June 2 June 9. 16. 436.
Mineral Resources 1897. And E.& M.Jour Sep. 28. 1895
Although the use of mica is substantially limited to the doors of anthracite stoves, its annual product in later years is valued at $75000- $100,000. Muscovite or less frequently phlogopite supplies the marketable kinds. It is produced in North Carolina and New Hampshire, and to a far less degree in the Black Hills, in New Mexico and elsewhere in the west. N.C. leads with N.H. second. The mica occurs in the south in great, coarsely crystalline granite dikes or veins, more probably the latter, of the segregated type, and the result of aqueo igneous action. The veins are in gneiss. The New England mines are said by Prof Shaler to be on beds. The occurrence of great granite veins or dikes in the Black Hills was referred to under Tin. The mica is by no means the largest component of the vein, but is in scattered bunches, mingled with quartz, feldspar and a variety of minerals. These same veins occur within the city limits of New York and recently some fine large plates have been obtained.

Barite.

Mineral Resources all the volumes.

Barite valued at $30-$5000, is produced annually and used in paints, and for chemical purposes. It occurs especially from Missouri and Virginia. In Mo. it occurs in the region south from St. Louis, more but not with the lead mines mentioned under Type 23. In south west Virginia in the region mentioned under Type 27 other masses of barite are found in veins, and in various parts of the country it is a common vein filling. Chester Conn. is a well known locality and the gneiss voing of the Miss. Valley, Type 24 contain it.

Sulphur.

Foreign E.& M.Jour June 16. '00. p.635. Sulphur Mines of the Caucasus.
E.& M.Jour. Aug. 9. 1879. p.89. The Sulphur Dep. in Iceland.
E.& M.Jour. Sep. 1 & 8.'00. p.174.The Sulphur Mines of Sicily.
Higgins N.S. Sulphur Dep. of the Island of Saba. Dutch W.I.
A.J.S. II. 40. 270. Extract from a Report.

Utah Faber du Faur A. The Sulphur Deposits of S.Utah M.E. 16. 33
vom Rath G. Neues Jahbuch 1884. 1.
& Nev. Russell I.C. Sulphur Dep. in Utah and Nev. E.& M.Jour
Jan 20. '83. p.31. On the general geology of the Nev.
region, see Russells Monograph on Lake Lahoutan U.S.G.S.
Russel I.C. Sulphur Deposits of Utah & Nev. Trans. N.Y. Acad
Sci. 1881. -83 p.168

Sulphur occurs in important quantities at a number of places in the west and from these it has been practicably obtained. The most important are the Cove Creek District in Millard Co. Utah, and the Rabbit Hole Mines in Humboldt Co. northwestern Nevada. The Sulphur Bank described under Type 55a, has furnished considerable sulphur in previous years. Sulphur is also known but in small quantities at Humboldt House, Humboldt Co. Nev. where it occurs in the cones of defunct hot springs 20&50' high. In the Rabbit Hole Mines the sulphur fills cavities in a breccia which are often of considerable size. The deposits extend several miles along the northern edge of the Black Rock Desert and are thought to be on a north and south faulted belt, and to have been filled by sublimation from below perhaps in part as H_2S. The Cove Creek Mines are now the only producers, According to Russell they are of three types.

The largest fills an extinct solfatara forming a circular deposit 1000' in diameter and averaging 25' thick of sulphur and earthy materials. The second type consists of volcanic tufa impregnated with sulphur, over an extended area. The third type is on fissures either in trachyte or Carboniferous limestone, and the sides are lined with crystals. All these lie along the border between the Colorado Plateau and the Great Basin, and are closely associated with eruptive outbreaks. The sulphur has probably been sublimed from great depths along with CO_2 etc. and condensed above.

It is still forming. Beds of gypsum and alum are associated. Lack of cheap transportation militates against these mines. Sulphur is also known in the Aleutian Islands in quantity.

Sulphur occurs as an interesting mineral in the gypsum beds, at Union Springs, on Cayuga Lake, and has resulted from the alteration of gypsum. The Sicilian deposits which chiefly supply the world, have been formed in this way.

Review of the course in the form of a brief summary of the resources of each individual state and territory from Maine westward to Alaska, the lecturer being followed on maps.

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Utah Baker du Faur A. The Sulphur Deposits of S.Utah M.E. 16. 83

von Rath G. Neues Jahrb. f. 1884. 1.

& Nev. Russell I.C. Sulphur Dep. in Utah and Nev. U.S.G.S.

Ann 20. '03. p.31. On the general geology of the Nev.

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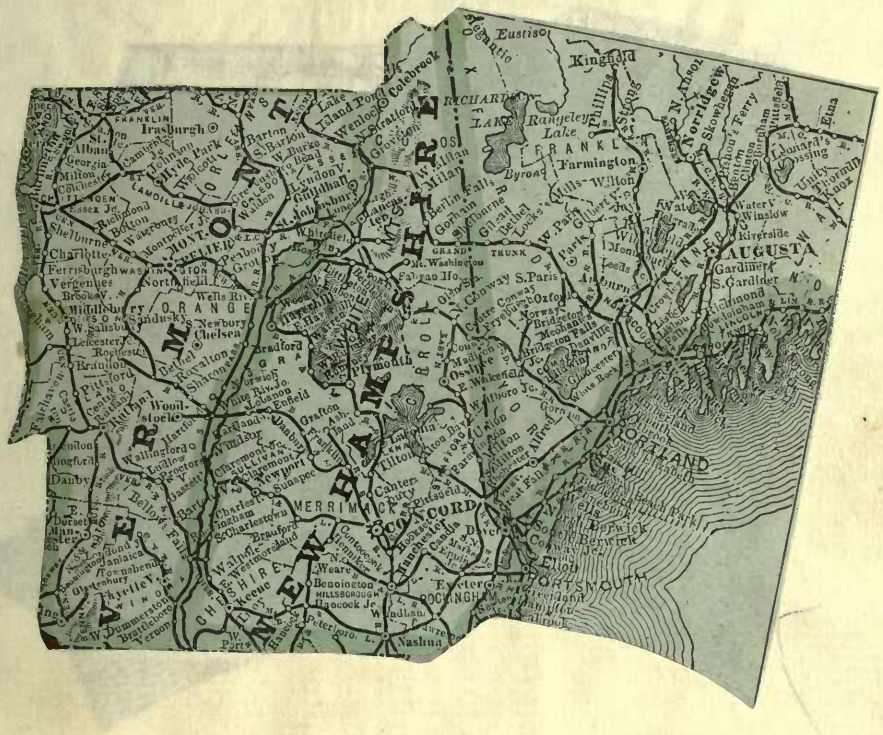
Russel I.C. Sulphur Deposits of Utah & Nev. Trans. N.Y. Acad

Sci. 1881. -83 p.189

e 16. Chalcopyrite. Ely Mt.



Iron

e 4. Sideroite. Roxbury. Conn

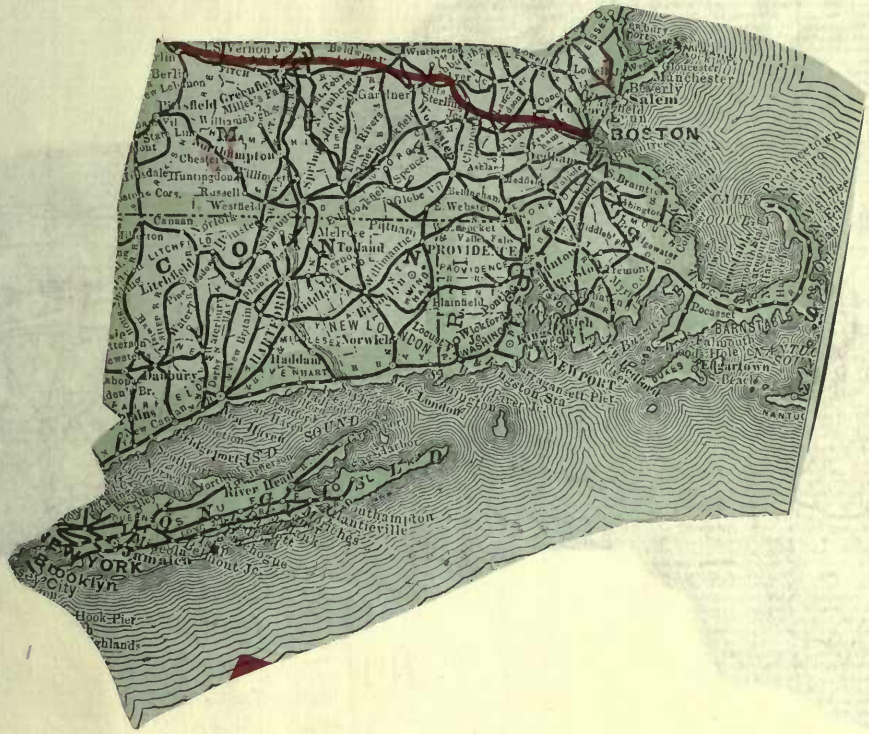
Copper

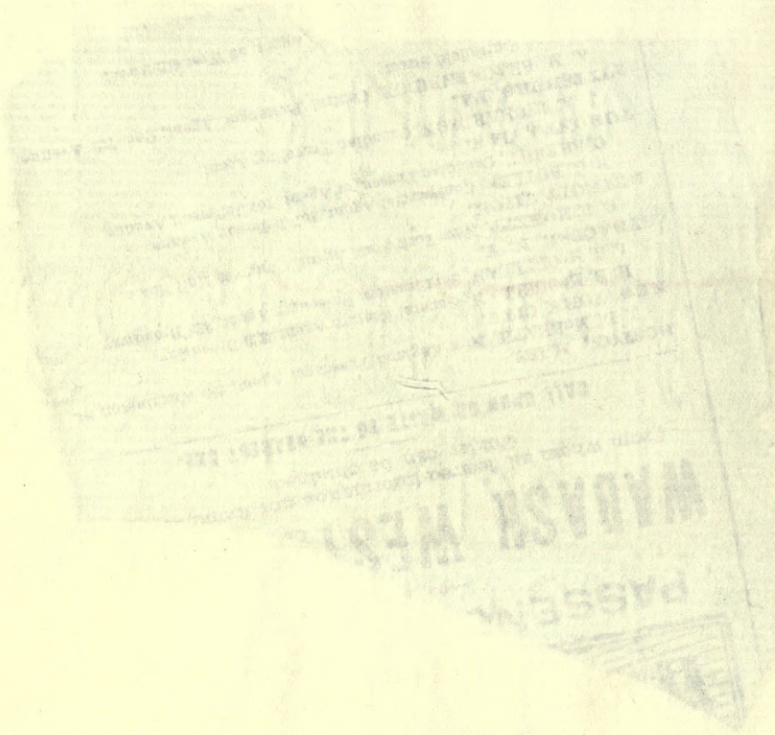
e 21b Chalcocite. Bristol Conn.

Lead.

22a. Galena Northampton Mass.

" " Middletown Conn



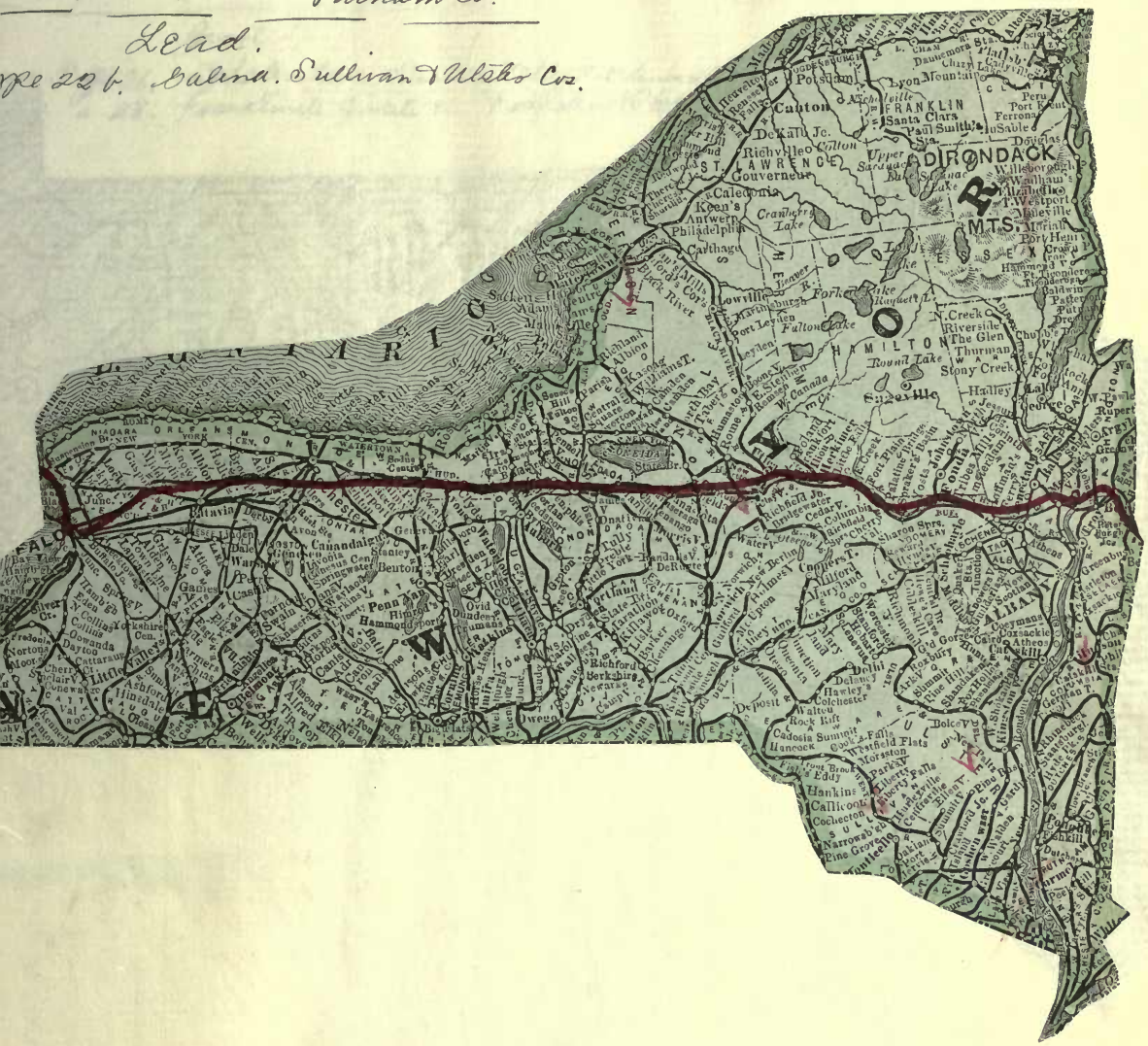


Iron.

ype 1a. Limonite. Staten Island.
" 3 Siderite. near Hudson City.
" " Ulster Co
" 6 Hematite. Clinton.
" 8 " Jefferson Co.
" 13a Magnetite. Adirondacks.
" 13b " Putnam Co.

Lead.

ype 22b. Galena. Sullivan & Ulster Cos.



Iron

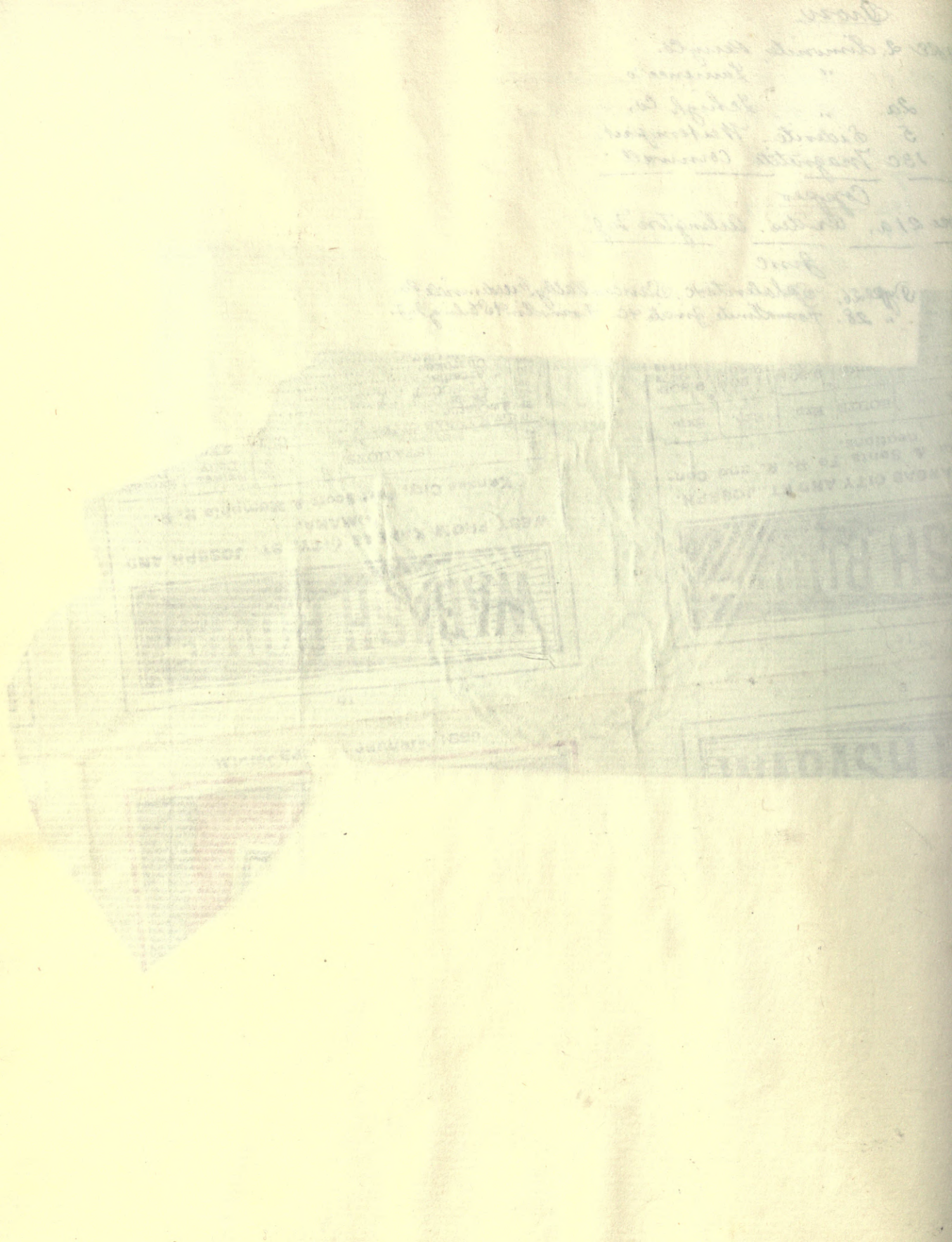
Type 2. Limonite, Perry Co.
" " Lawrence Co
" 2a. " Lehigh Co.
" 5 Siderite, Western part.
" 13C Magnetite Cornwall.

Copper

Type 21a. Oxides. Arlington N.J.

Zinc

Type 26. Sphalerite &c. Saucon Valley Friedensville Pa.
" 28. Franklinite, Zincite &c. Franklin & Sterling N.J.



Limonite; Lowmarre & Long - dale Va.

Hematite. Greenbrier Co, W. Va.

" James River, Va. near Lynchburg.

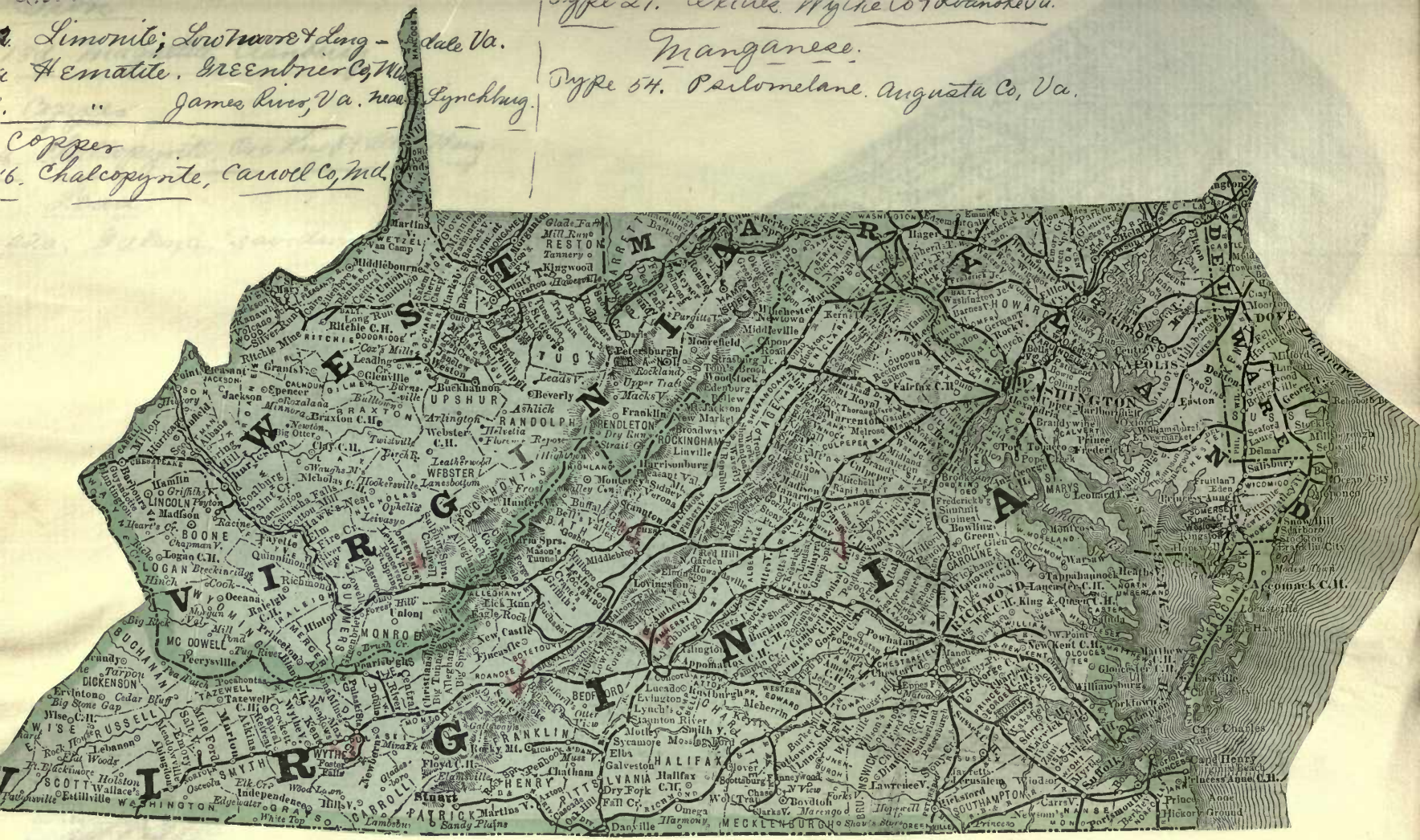
Copper

6. Chalcopyrite, Carroll Co, Md.

Type 27. Wythe Co, Roanoke Co.

Manganese.

Type 54. Psilomelane. Augusta Co, Va.


WEST VIRGINIA
VIRGINIA
MARYLAND
DELAWARE
WASHINGTON
ALEXANDRIA
ANNAPOLIS
RICHMOND
Martinsburg
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Winchester
Fredericksburg
Alexandria
Washington
Baltimore
Annapolis
Wheeling
Parkersburg
Charleston
Lewisburg
Staunton
Lynchburg
Danville
Petersburg
Norfolk
Portsmouth
Williamsburg
Yorktown
Richmond
Fredericksburg
Culpeper
Warrenton
Leesburg
Harrisonburg
Winchester
Romney
Morgantown
Clarksburg
Fairmont
Grafton
Buckhannon
Weston
Webster
Braxton
Upshur
Randolph
Barbour
Tucker
Preston
Monongalia
Marion
Harrison
Taylor
Doddridge
Ritchie
Wood
Jackson
Mason
Putnam
Kanawha
Boone
Logan
Wyoming
McDowell
Mercer
Monroe
Greenbrier
Pocahontas
Nicholas
Fayette
Raleigh
Summers
Mercer
Tazewell
Buchanan
Dickenson
Wise
Russell
Scott
Lee
Smyth
Wythe
Grayson
Carroll
Floyd
Montgomery
Giles
Pulaski
Bland
Craig
Roanoke
Botetourt
Alleghany
Bath
Highland
Augusta
Rockingham
Shenandoah
Page
Frederick
Clarke
Loudoun
Fairfax
Prince William
Stafford
Fauquier
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Culpeper
Orange
Madison
Greene
Albemarle
Nelson
Amherst
Campbell
Bedford
Franklin
Pittsylvania
Halifax
Henry
Patrick
Floyd
Carroll
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Montgomery
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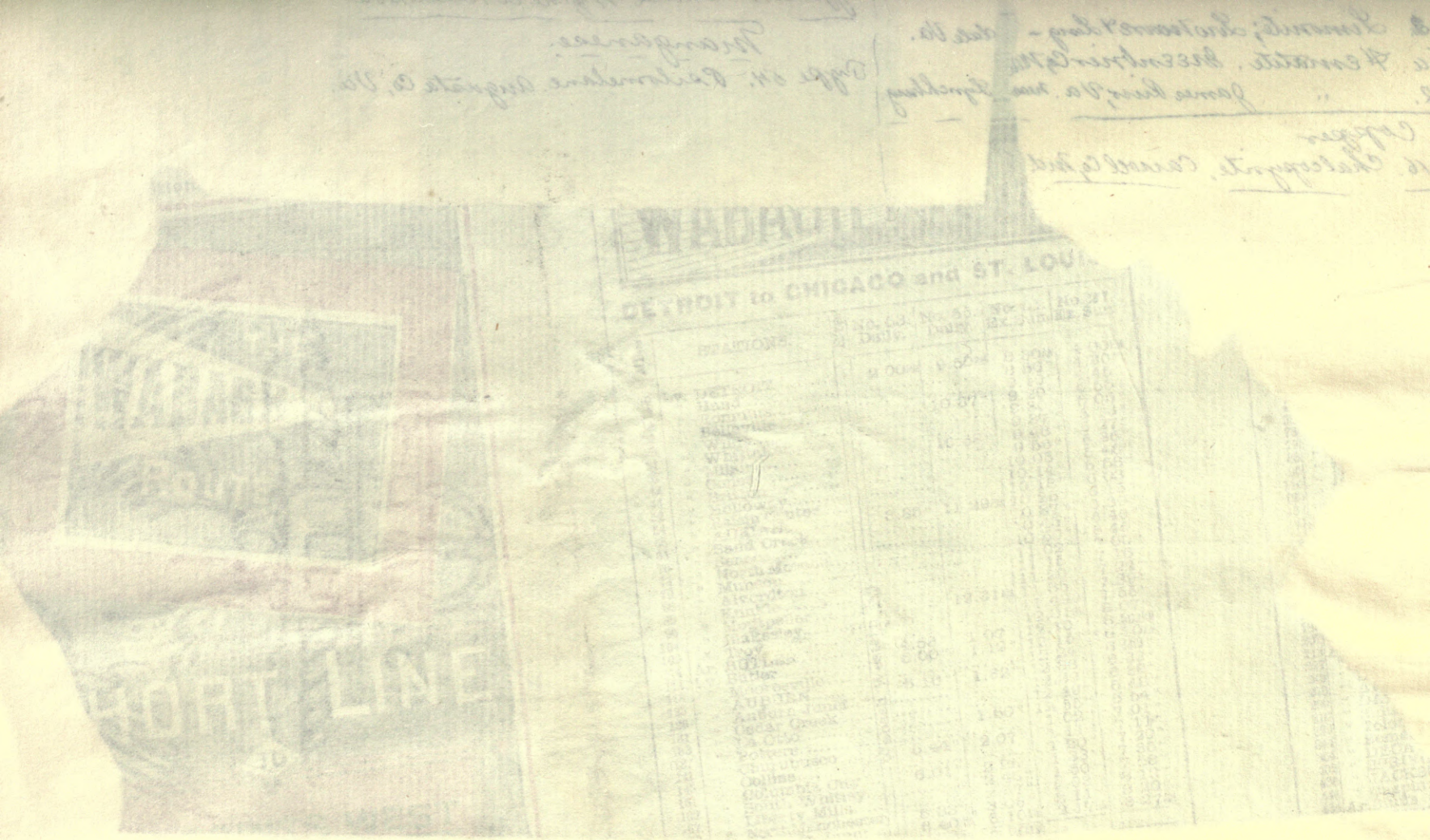

WABASH
DETROIT to CHICAGO and ST. LOU
SHORT LINE

Iron

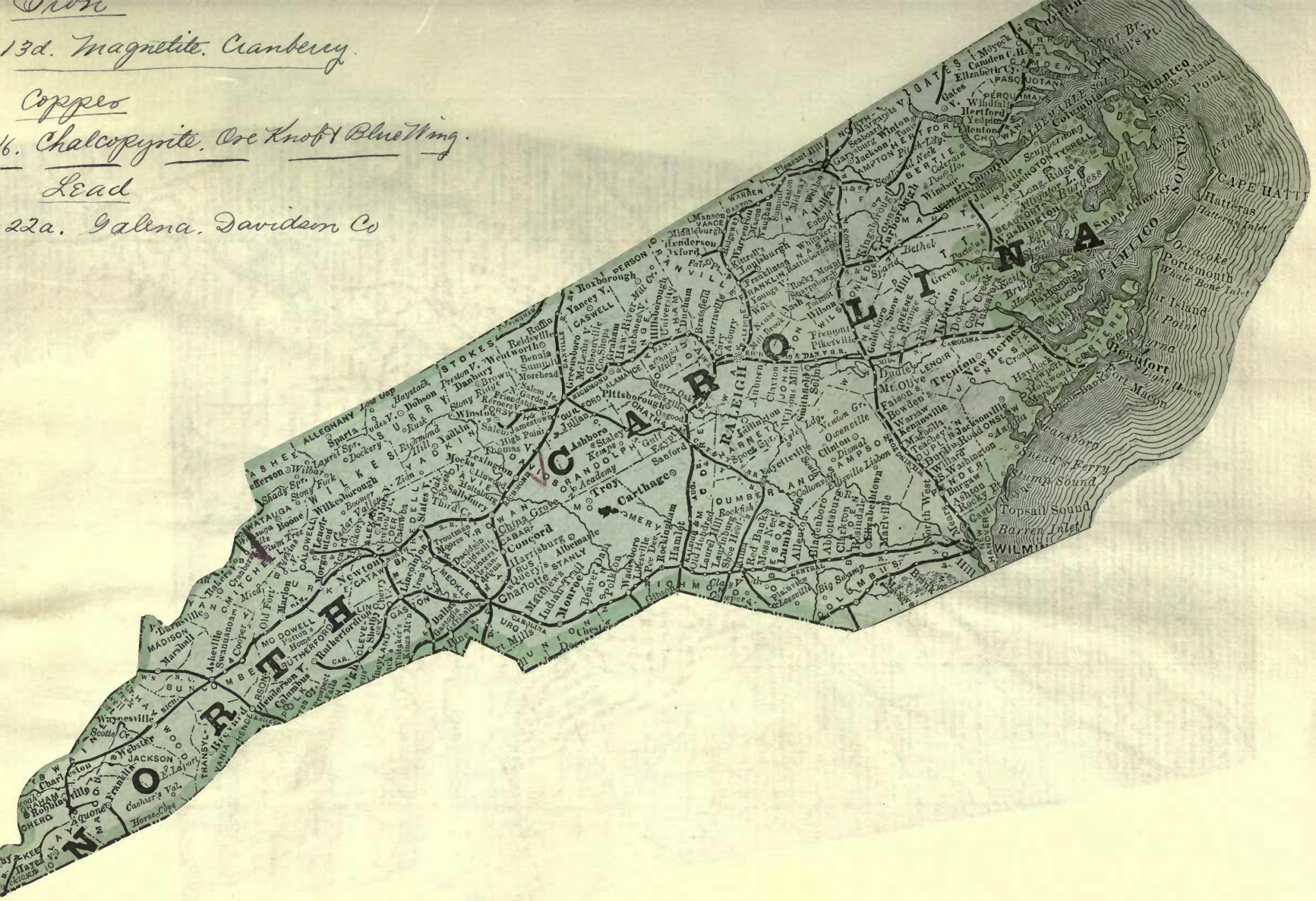
13d. Magnetite. Cranberry.

Copper

16. Chalcopyrite. Ore Knob & Blue Wing.

Lead

22a. Galena. Davidson Co


NORTH CAROLINA
Carthage
Troy
Albemarle
Concord
Charlotte
Monroe
Wadesboro
Rockingham
Hamlet
Lumberton
Fayetteville
Raleigh
Durham
Roxboro
Yanceyv.
Danbury
Wilkesboro
Statesville
Salisbury
Lexington
Asheboro
Greensboro
Reidsville
Winston
Salem
High Point
Hillsborough
Chapel Hill
Pittsboro
Sanford
Southern Pines
Laurinburg
Red Banks
Shoe Heel
Rockfish
Elizabethtown
Whiteville
Clarkton
Tabor
Bladenboro
Columbus
Chadbourn
Marion
Old Fort
Asheville
Hendersonville
Brevard
Hayesville
Webster
Waynesville
Sylva
Bryson
Franklin
Murphy
Andrews
Robbinsville
Lenoir
Morganton
Newton
Hickory
Lincolnton
Gastonia
Shelby
Rutherfordton
Spindale
Forest City
Burnsville
Marshall
Madison
Yancey
Mitchell
Avery
Watauga
Ashe
Alleghany
Wilkes
Stokes
Surry
Rockingham
Caswell
Person
Granville
Vance
Warren
Franklin
Nash
Wilson
Greene
Lenoir
Jones
Craven
Pamlico
Carteret
Onslow
Pender
New Hanover
Brunswick
Columbus
Bladen
Robeson
Scotland
Richmond
Montgomery
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Davie
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Transylvania
Henderson
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Rutherford
McDowell
Burke
Caldwell
Watauga
Ashe
Alleghany
Wilkes
Yadkin
Davie
Iredell
Alexander
Catawba
Cleveland
Gaston
Lincoln
Mecklenburg
Union
Anson
Richmond
Scotland
Hoke
Cumberland
Harnett
Johnston
Wayne
Lenoir
Greene
Pitt
Martin
Bertie
Hertford
Gates
Chowan
Perquimans
Pasquotank
Camden
Currituck
Dare
Hyde
Tyrrell
Washington
Beaufort
Pamlico
Craven
Jones
Onslow
Pender
New Hanover
Brunswick
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Bladen
Robeson
Hoke
Cumberland
Harnett
Johnston
Wayne
Sampson
Duplin
Wilson
Nash
Edgecombe
Halifax
Northampton
Vance
Warren
Franklin
Granville
Person
Caswell
Rockingham
Stokes
Surry

LAUDERDALE
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Bridgeport
Stevenson
LIMESTONE
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JACKSON
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Deer Head
Rising Fawn
Sulphur Spgs.
Tuscumbia
COLBERT
Spring Valley
Littleville
Good Spgs.
Decatur
Madison
Gurley
Paint Rock
Woodville
Bellefonte
James
Pea Ridge
Valley Head
Mahan
Allen
Black Oak
Cardell
LAWRENCE
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MORGAN
Somerville
Cottonville
Fort Payne
New Moon
Bel Green
FRANKLIN
Darlington
Landersville
Oakville
Falkville
Fort Bluff
Cleander
Henryville
Collbran
Broomtown
Spruce Pine
Mountain Spgs.
Wilhites
Warrenton
Guntersville
Ringgold
Bear Creek
Collier Creek
Ark
Lebanon
Porterville
Firestone
Haleyville
WINSTON
Double Spgs.
Balleyton
Albertville
Crossville
Collinsville
Stella
MARION
Hamilton
Houston
Cullman
Logan
Brooks
Friendship
Reed Hill
Chumley
Keener
CHEROKEE
Rayne
Barnesville
Delmar
Pearces Mills
Browns Creek
Mates
Hanceville
Liberty
Aurora
Roseville
Walnut Grove
Blountsville
Rock Land
Centre
Pikeville
Lynn
Gold Mine
Elk
Bremen
Garden City
Gum Spring
ATTALLA
Turkeytown
Tecumseh
Dutton
Crews
Ur
Nauvoo
Kirk
Bangor
Chepultepec
Steele
Gadsden
Amberson
Gala
Glen Allen
Carbon Hill
WALKER
Gamble
Jasper
Blount Spgs.
Reids
Viola
Whitney
Nowlin
Rock Spgs.
Woodward
Reads
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Glo
Piedmont
Talladega
Moscow
Vernon
FAYETTE
Spencer
Townley
Cordova
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Compton
Caldwell
Lochtree
Duke
E. & W. Jc.
Jacksonville
LAMAR
Kingville
GEORGIA
Fayette
Berry
Corona
Days Gap
Pacific
Springville
Cornelia
Fairview
Alexandria
Anniston
Edwardsville
Parrish
Bankston
Parkville
Trussville
Morris
Argo
Broken Arrow
Pell City
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Wilmington
Oregonia
Kennedy
Branchville
Oxford
CLEBURNE
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Jenifer
Chulafinnee
Palmetto
Marousville
Binione Creek
Hillman
Kellys Creek
Henry Ellen
McElderry
Clifton
Ironaton
Delta
Graham
Stafford
McConnells
Hayes
Jonesboro
Ozmoor
Dunnavant
Talladega
Rockdale
Lineburg
Temple
Samanths
Tuscaloosa
McCalla
Brooks Gap
Weldon
Alpine
Carlton
Bercys
Lincville
Redwood
Omaha
PICKENS
Rae
Sipsey Turnpike
Woodstock
Tannehill
Highland
Vincent
Rendalia
Wevoka
Hillabee
Ashland
RANDOLPH
Carrolliton
Raleigh
Sipsey
Pleasant Grove
Dudley
Calling
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Childersburg
Sycamore
Bluff Spr.
High Shoals
Roanoke
Pickensville
Garden
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Helena
Longview
Wilsonville
Fayetteville
Sylacauga
Louina
Memphis
Bethania
Foster
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Aldrich
Pinckneyville
Milltown
Strond
Tuskaloosa
Mantua
Sylvan
Holt
New Marie
Bloctou
Montevallo
Columbiana
Shelby
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Fredonia
Pleasant Ridge
Skelton
Briarfield
Ashby
Stewartsville
Goodwater
Hackneyville
Kellyton
Matilda
Knoxville
Haglers
Clear Creek
Marble Valley
Buffalo
Sherman
W. Greene
Carthage
Centreville
Six Mile
Jemison
Crewsville
Dudleyville
LaFayette
Clinton
Stewart
Akron
Havana
Harrisburg
Strasburg
Rockford
Alexander Cy.
Jacksons Gap
Warsaw
GREENE
Five Mile
Randolph
Lomax
Pentonville
Mc.Hebron
Eutaw
Evans
Abercrombie
CHILTON
Clanton
Travellers Rest
Dadeville
Sandy Cr.
Hainesville
Sawyerville
Brush Cr.
Theo
Tucky
Maplesville
Coopers
Camp Hill
Tuckersburg
Epes
Miller
Hollis
Greensboro
Kinchoe
Mountain Creek
Waverly
Old Hill
Opelika
Lower Salem
Dixie
Central Institute
Auburn
Loachapoka
Notasulga
Chehaw
Franklin
Tuskegee
Girard
Fort Mitchell
Seale
Hatchechubbee
Hurtsboro
Glenville
Guerryton
Jernigan
Union Spgs.
Three Notch Road
Midway
Spring Hill
Batesville
Inverness
Cochran
Mt. Andrew
Eufaula
Perote
Clayton
Monticello
White Oak
Barbour
Louisville
Elamville
Lawrenceville
Clopton
Shorterville
Abbeville
Zornville
Smithville
Columbia
Cowarts
Dothan
Taylor
Gordon
Cottonwood
Granger
Warwick
Geneva
Coffee Spgs.
High Falls
Wicksburg
Alberton
Clayhatchee
Cross Trails
Dalevile
Newton
Damascus
Clintonville
Elba
Victoria
Roeton
Barnes
Ozark
Hawkinsville
Brundidge
Troy
Pike Level
Bullock
Pea Ridge
Mahan
Valley Head
Allen
Black Oak
Cardell
Fort Payne
New Moon
Broomtown
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Firestone
Stella
Rayne
Cave
Centre
Tecumseh
Gadsden
Amberson
Rock Spgs.
Woodward
Reads
Piedmont
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Anniston
Edwardsville
Oxford
Coldwater
Jenifer
Chulafinnee
CLEBURNE
Graham
Rockdale
Omaha
Talladega
Lincville
Redwood
Carlton
Bercys
Rendalia
Wevoka
Sycamore
Hillabee
Ashland
Bluff Spr.
Sylacauga
Pinckneyville
Whelerville
High Shoals
Roanoke
Louina
RANDOLPH
Milltown
Strond
Fredonia
Buffalo
LaFayette
Dudleyville
Alexander Cy.
Jacksons Gap
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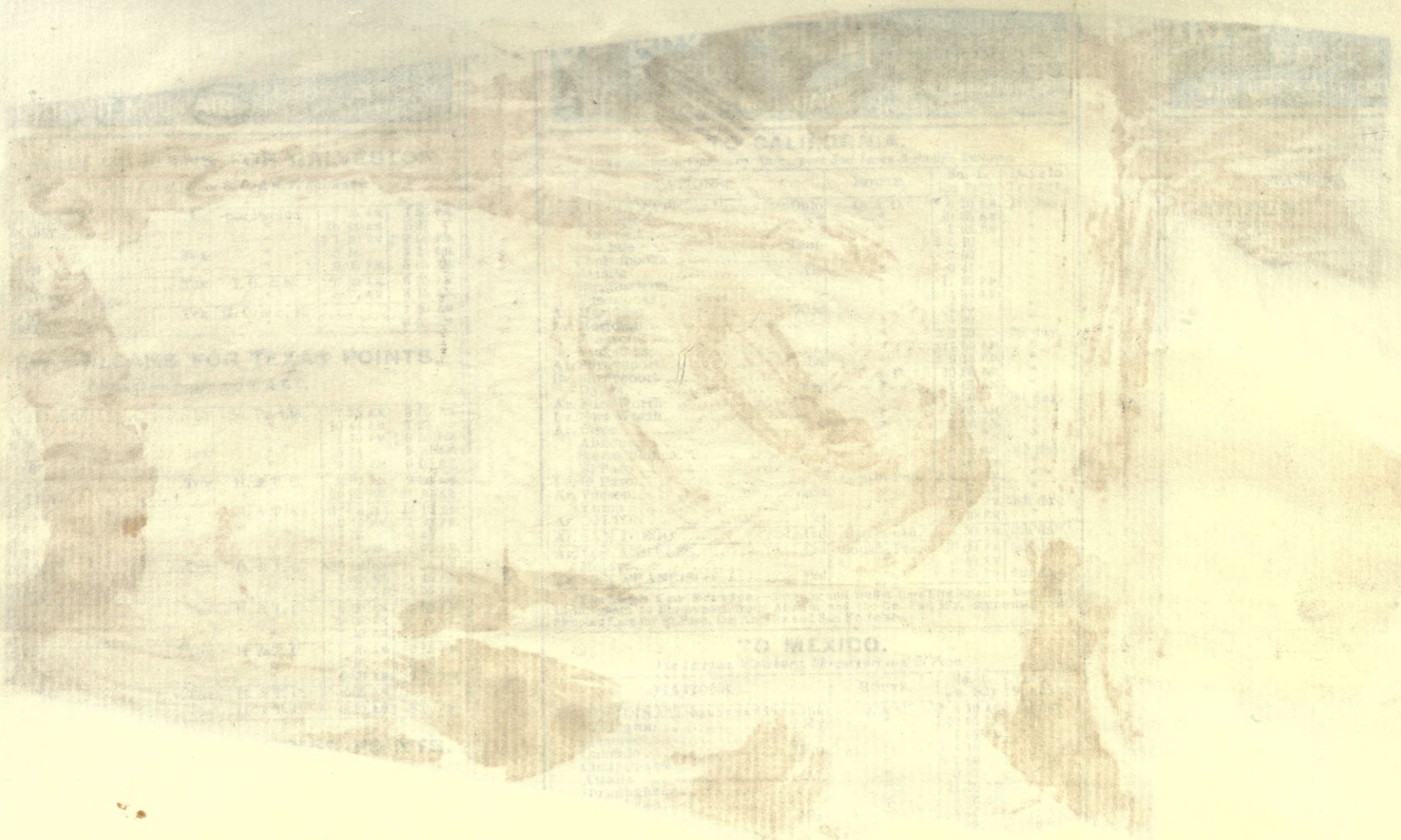
Matilda
Daviston
Delta
Ironaton
Graham
Rockdale
Omaha
Redwood
Lincville
Talladega



MISSISSIPPI
Corinth
Hernando
Holly Sprs.
Ripley
New Albany
Oxford
Tupelo
Water Valley
Coffeeville
Pittsboro
Houston
Aberdeen
Grenada
Williamsville
Elliott
Walthall
West Point
Greenwood
Winona
Carrollton
Indianola
Starkville
Chester
Louisville
Kosciusko
Philadelphia
De Kalb
Yazoo City
Carthage
Forest
Canton
Enterprise
Meridian
Vicksburg
Jackson
Raymond
Brookhaven
Natchez
Hattiesburg
Laurel
Ellisville
Columbia
Magnolia
McComb
Liberty
Wilkinson
Amite
Pike
Lincoln
Lawrence
Simpson
Smith
Jasper
Clarke
Wayne
Jones
Perry
Greene
Harrison
Jackson
George
Stone
Pearl R.
Yazoo R.
Big Black R.
Pascagoula R.
Chickasawhay R.
Leaf R.
Tallahala Cr.
Okatoma Cr.
Bogue Chitto
Red Cr.
Flint Creek
Biloxi
Gulfport
Pass Christian
Bay St. Louis
Ocean Springs
Mississippi Sound
Chandeleur Sound
New Orleans & North Eastern R.R.
Mobile & Ohio R.R.
Illinois Central R.R.
Alabama & Vicksburg R.R.
Vicksburg & Meridian R.R.

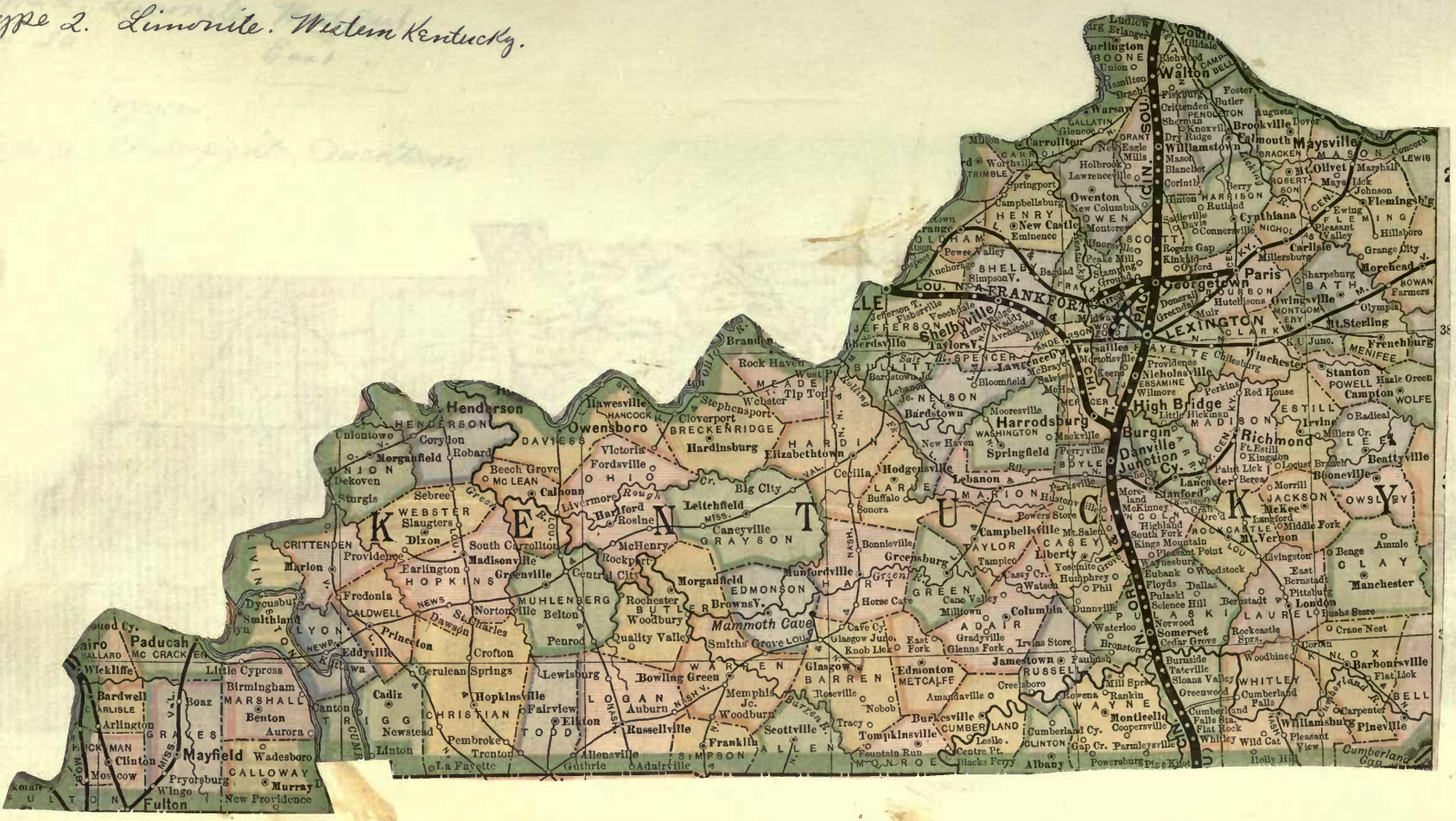
VICKSBURG
SHREVEPORT
SHREVEPORT & PACIFIC
TEXAS & PACIFIC
Delhi Br.
Harrisonburg
Natchitoches
Alexandria
Marksville
Pineville
Colfax
Cotton Valley
Lake Providence
Bastrop
Winnsboro
Columbia
Farmersville
Homer
Minden
Sibley
Mansfield
Coushatta
Red River
Grand Ecore
Many
Leesville
Oakdale
Jennings
Crowley
Lafayette
New Iberia
Morgan City
Franklin
Abbeville
Vermilion Bay
Cameron
Lake Charles
Calcasieu
Lake Arthur
Donaldsonville
Thibodeaux
Houma
Lockport
Baton Rouge
Port Allen
Plaquemine
Port Vincent
Springfield
Livingston
Hammond
Amite City
Independence
Tangipahoa
Ponchatoula
Covington
Madisonville
Mandeville
Slidell
Pearl River
Algiers
NEW ORLEANS
St. Bernard
Shell Beach
Hopedale
Chalmette
Arabi
Kenner
Lake Pontchartrain
Lake Borgne
Bayou Lafourche
Terrebonne Bay
Dulac
Pt. aux Fer
Raccoon Pt.
Caillou Bay
Lake Caillou
Grand Isle
Barataria Bay
Empire
Venice
Olga
Jump
Pilot Town
Pointe a la Hache
Diamond
Home Place
Belair
Jesuits Bend
Hahnville
Lutcher
Gramercy
Convent
Donaldsonville
Gonzales
Sorrento
Prairieville
Geismar
Sunshine
Addis
Port Hudson
Zachary
Baker
Greenwell Springs
Clinton
Greensburg
St. Helena
Jackson
Norwood
Wilson
Darlington
Sunny Hill
Palestine
Arcadia
Peace Grove
Chinquapin
Lees Creek
Talisheek
Pearl River
Nicholson
Violin
Bogalusa
Franklinton
Bush
Folsom
Abita Springs
Mandeville
Lacombe
Pearlington
Logtown
Kiln
Delisle
Wiggins
Poplarville
Lumberton
Purvis
Columbia
Hattiesburg
Petal
Carriere
Picayune
Napoleonville
Paincourtville
St. James
Convent
Mt. Airy
Burnside
Gardere
Colyell
Springfield
Live Oak Store
Plain View
Hill Springs
Springville
Grangeville
Pine Grove
Dennis Hill
Slaughter
Bayou Sara
Ethel
Wilson
Jackson
Clinton
Greensburg
St. Helena
Norwood
Lookout
Darlington
Sunny Hill
Palestine
Balltown
Tangipahoa
Arcadia
Peace Grove
Chinquapin
Lees Creek
Amite City
Independence
Talisheek
Hammond
Ponchatoula
Covington
Madisonville
Mandeville
Slidell
Pearl River
Violin
Nicholson
Bogalusa
Franklinton
Bush
Folsom
Abita Springs

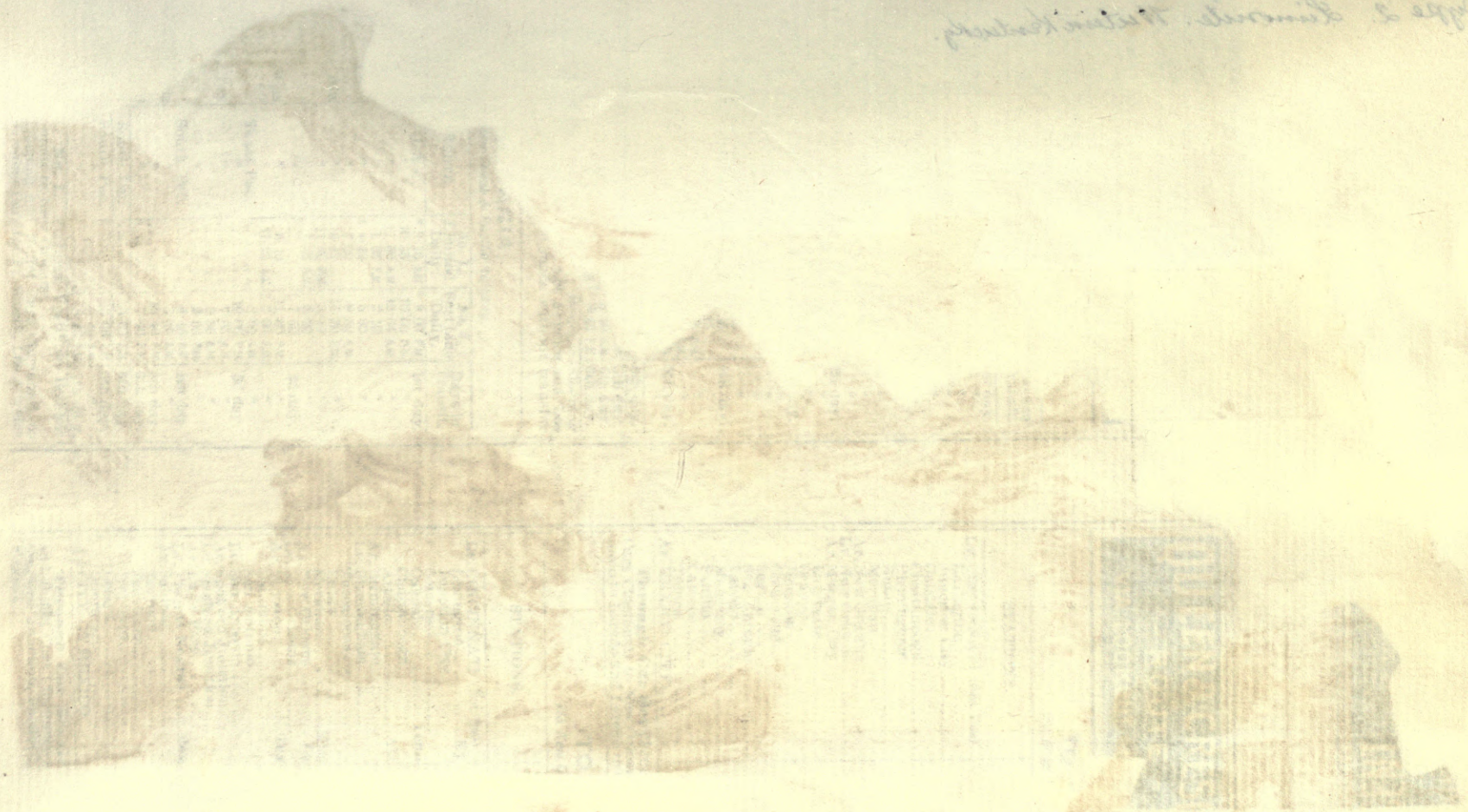
Limonite

Salt.

Iron.

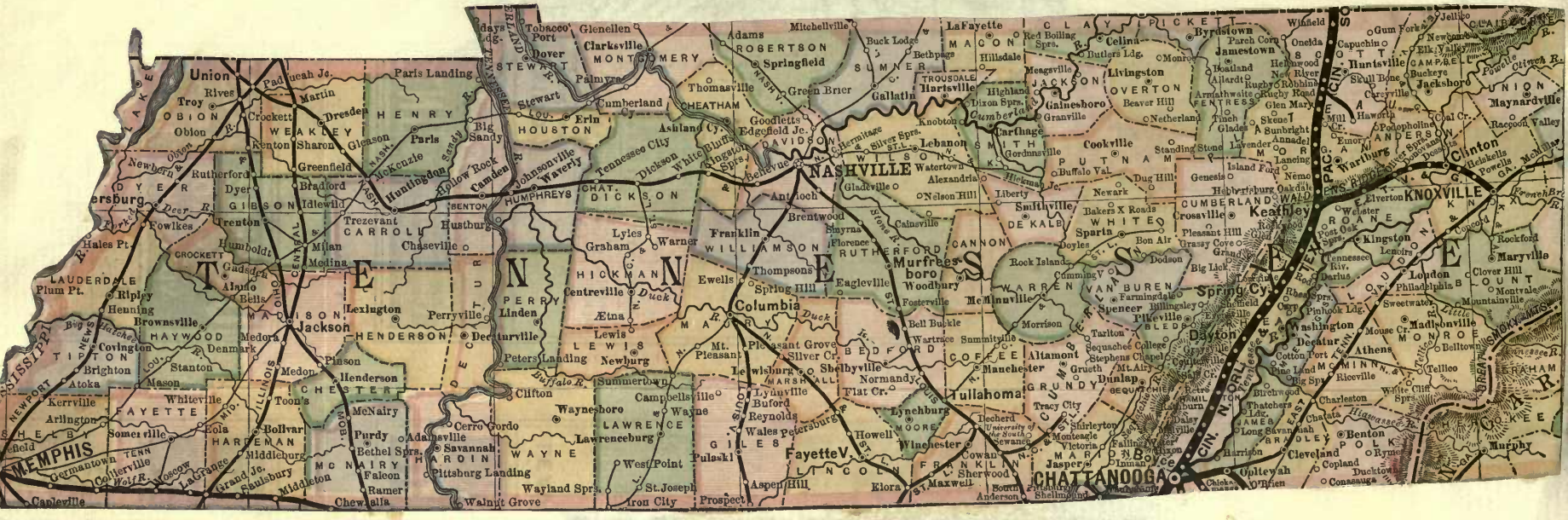
ppe 2. Limonite. Western Kentucky.





ype 2. Limonite. West part.
" 2a " East "

Copper.
ype 16. Chalcopyrite. Ducktown



Iron.

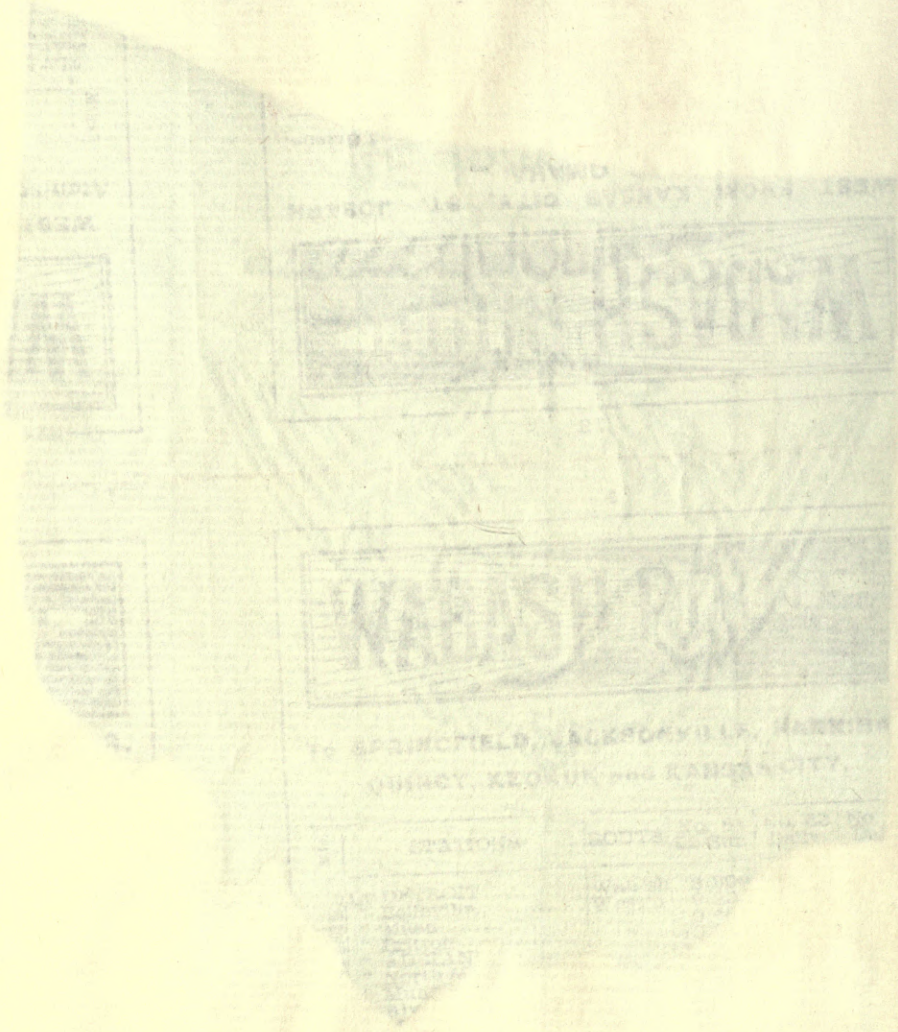
Res 675a. Siderite. Chiefly mcc.

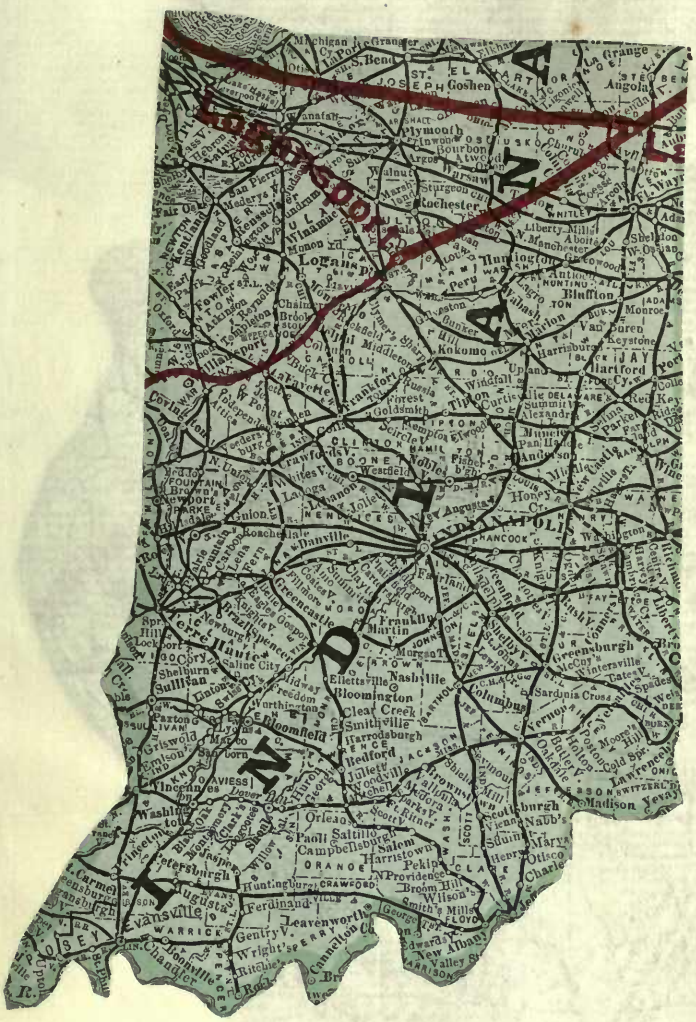
2

Building Stone
Coal.
Spathic Ores.

} East.

Petroleum




INDIANA
Michigan
Grange
Goshen
Plymouth
Rochester
Logans
Huntington
Bluffton
Kokomo
Tipton
Hartford
Indianapolis
Greenfield
Greenburgh
Franklin
Martin
Morgan
Nashville
Columbus
Bloomington
Clear Creek
Smithville
Harrodsburgh
Bedford
Juliet
Orleans
Paoli
Campbellsburgh
Salem
Harristown
Providence
Pekin
Broom Hill
Wilson's
Smith's Mills
Ferdinand
Jeavenworth
Gentry V.
Wright's
Vansville
Augusta
Huntingburg
Petersburgh
Washington
Vincennes
Sullivan
Shelburn
Saline City
Hunter
Greencastle
Danville
Roachdale
Union
Madison
Jenny
Otisco
Charlestown
Naub's
Sardinia
Cross
Sinteraville
Tate V.
Lawrenceburgh
Cold Spr.
Moore Hill
Aurora
Rising Sun
Lawrenceburg
Madison
Jeffersonville
Charlestown
Utica
Mary's
Salt Creek
Hanover
Scott
Jackson
Washington
Clark
Floyd
Harrison
Crawford
Orange
Perry
Spencer
Warrick
Gibson
Knox
Daviess
Martin
Greene
Owen
Morgan
Johnson
Shelby
Hancock
Marion
Hamilton
Boone
Clinton
Tippecanoe
Carroll
Cass
Miami
Wabash
Huntington
Whitley
Noble
Kosciusko
Fulton
Pulaski
Starke
Lake
Porter
LaPorte
St. Joseph
Elkhart
Marshall
Fulton
Pulaski
Jay
Adams
Wells
Blackford
Grant
Delaware
Randolph
Henry
Hancock
Shelby
Rush
Fayette
Union
Franklin
Ripley
Jennings
Decatur
Bartholomew
Brown
Monroe
Lawrence
Jackson
Scott
Clark
Floyd
Harrison
Crawford
Orange
Dubois
Pike
Gibson
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Warrick
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Perry
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Daviess
Knox
Sullivan
Vigo
Clay
Owen
Greene
Monroe
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Bartholomew
Jackson
Jennings
Ripley
Switzerland
Dearborn
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Union
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Randolph
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Adams
Wells
Blackford
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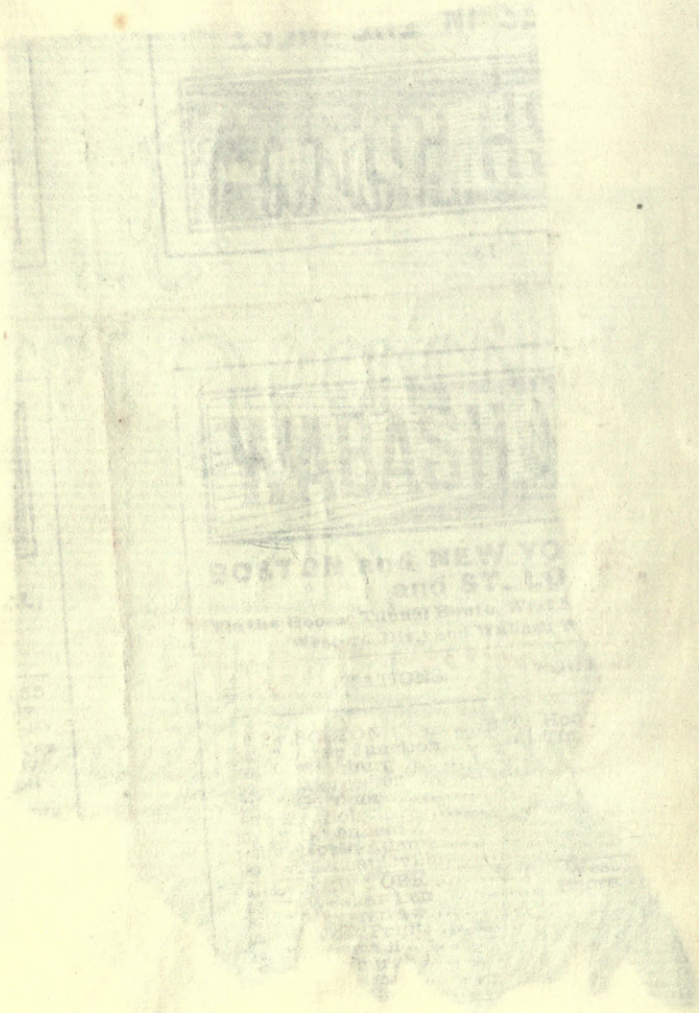
Delaware
Madison
Hamilton
Tipton
Howard
Miami
Wabash
Huntington
Whitley
Noble
Kosciusko
Fulton
Pulaski
Starke
Lake
Porter
LaPorte
St. Joseph
Elkhart
Marshall

Coal

Gas

Building Stone



ILLINOIS
Hannibal
Quincy
Galena
JO DAVIESS
STEPHENSON
BOONE
WINNEBAGO
CARROLL
Mt. Morris
OGLE
DE KALB
KANE
DU PAGE
WHITESIDE
Sterling
LEE
Dixon
Amboy
LA SALLE
Ottawa
Morris
Joliet
Plainfield
WILL
Aurora
Naperville
Wheaton
Elgin
Geneva
Batavia
Chicago
BUREAU
Princeton
Tiskilwa
Sheffield
Henry
PUTNAM
Hennepin
Lostant
Utica
Peru
LaSalle
Ottawa
Marseilles
Seneca
Morris
Minooka
Joliet
Plainfield
Naperville
Aurora
Batavia
Geneva
Elgin
Wheaton
Chicago
Evanston
Waukegan
Lake Forest
Highland Park
Glencoe
Winnetka
Wilmette
Kenilworth
Evanston
Skokie
Niles
Maine
Leyden
Norwood Park
Jefferson
Lake View
Hyde Park
Calumet
Thornton
Bloom
Rich
Bremen
Lemont
Lyons
Riverside
Cicero
Berwyn
Oak Park
Proviso
Leyden
Addison
Bensenville
Wood Dale
Itasca
Bloomingdale
Roselle
Schaumburg
Palatine
Barrington
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Elk Grove
Wheeling
Prospect Heights
Arlington Heights
Mount Prospect
Des Plaines
Maine
Niles
Skokie
Evanston
Lake View
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Bloom
Rich
Bremen
Orion
Cambridge
Lynn
Ulah
Edwards
Rio
Alexis
Toulon
Oneida
Altona
Watauga
Monmouth
Gerlaw
Knox
Galesburg
Abingdon
Prairie City
Bushnell
Carthage
Bentley
Colchester
Tennessee
Macomb
Vermont
Astoria
Fairview
Prairie City
Bushnell
Walnut Gr
Prairie City
Carlton
Peoria
Farmdale
Pekin
Morton
Mount
Washington
Metamora
Kappa
Chenoa
Lexington
Normal
Bloomington
Mackinaw
Tazewell
Delavan
Green
Mackinaw
Minier
Lincoln
Atlanta
Hudson
Arrowsmith
McLean
Lexington
Leroy
Lawndale
Funks Grove
Shirley
Dawson
Mount Pulaski
Latham
Elkhart
Williamsville
Sherman
Chatham
Auburn
Springfield
Rochester
Berlin
Virginia
Petersburg
Sangamon
Ashland
Cass
Beardstown
Meredosia
Naples
Exeter
Jacksonville
Waverly
Morgan
Pittsfield
Pike
Calhoun
Hamburg
Brussels
Kane
Carrollton
Greene
Jersey
Macoupin
Carlinville
Girard
White Hall
Wrights
Virden
Auburn
Buffalo Hart
Decatur
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Harristown
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Niantic
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Illiopolis
Pana
Assumption
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Mowequa
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Shelbyville
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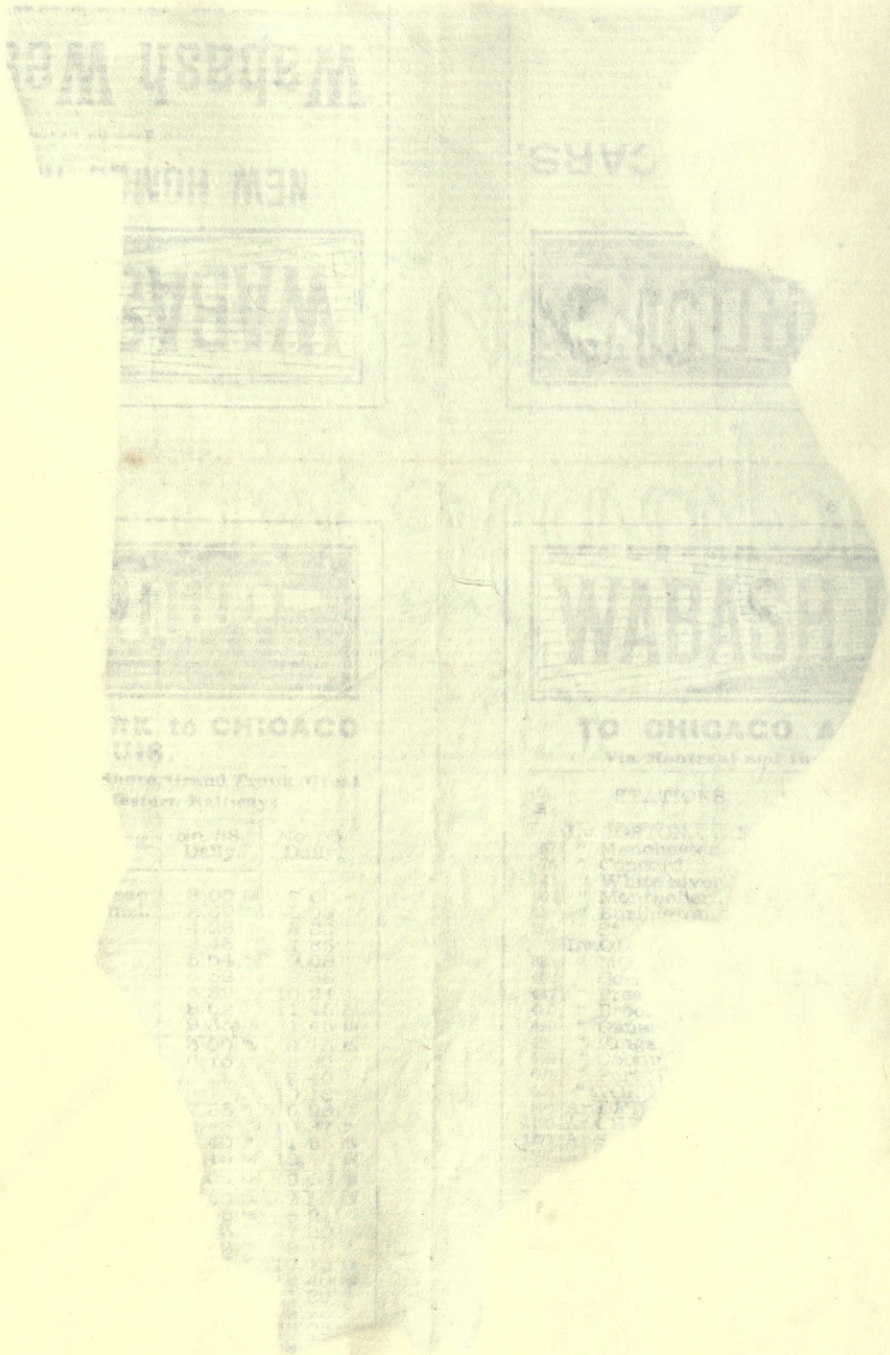
Litchfield
Raymond
Harvel
Nilwood
Staunton
Gillespie
Bunker Hill
Edwardsville
Alton
Godfrey
Upper Alton
Milton
Wood River
Hartford
Collinsville
Troy
Marine
Pontoon
Madison
Venice
Granite City
Nameoki
Pin Nicholas
Caseyville
Fairmont
Lebanon
Belleville
Centreville
Cahokia
Dupo
Prairie du Rocher
Fort Gage
Kaskaskia
Chester
Sparta
Ellis Grove
Evansville
Steeleville
Red Bud
Renault
Waterloo
Columbia
Monroe
Harrisonville
Ste. Genevieve
Perryville
Pinckneyville
Du Quoin
Tamaroa
Dubois
Radom
Opdyke
Coulterville
Sparta
Tilden
Steeleville
Ellis Grove
Evansville

Coal

Limestone.



Iron

e 9a. Hematite, Marquette Dist.

9b " Menominee "

9c " Gogebic "

Copper.

18. Native Copper. Keweenaw Pt.

Silver

35. Native, Silver Ls.

Gold

e 49a. Gold quartz. Ishpeming.

Coal
Gypsum
Salt.
} S. Peninsular

Hematite
Copper
Silver.
Ni S Cu Fe S_2
} N. Peninsular

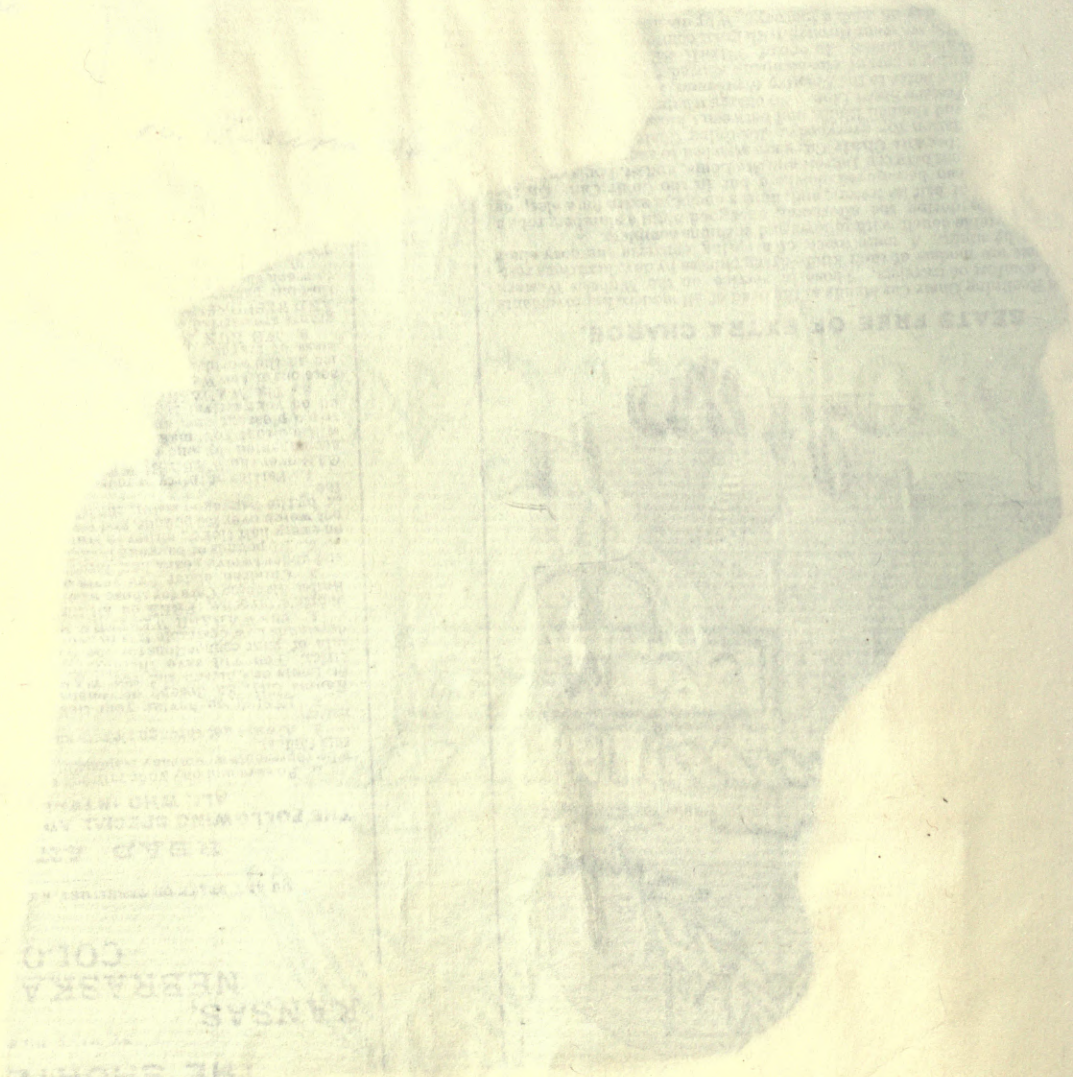
Iron

ce 6. Hematite. Dodge Co.

WISCONSIN
Iron
Florence
Oneida
Vilas
Forest
Langlade
Lincoln
Taylor
Price
Oconto
Marinette
Phillips
Pelican Sta
Pelican Lake
Crandon
Rusk
Sawyer
Ashland
Bad River
Glidden
Butternut
Washburn
Burnett
Grantsburg
Shell Lake
Cumberland
Barron
Polk
St. Croix
Dunn
Pepin
Pierce
Eau Claire
Chippewa
Rice Lake
Superior
Douglas
Bayfield
Merrill
Medford
Stetson V.
Dorchester
Abbotsford
Colby
Unity
Spencer
Marshfield
Withee
Stanley
Chelsea
Rib Lake
Wausau
Weston
Rothschild
Mosinee
Kronenwetter
Schofield
Antigo
Elcho
Summit Lake
Langlade
Birnamwood
Eland
Whitcomb
Tigerton
Deerbrook
Malcolm
Elmhurst
Aniwa
Pine River Sta
Pine Lake
Lily
Trout Lake
Big L.
Flambeau L.
Flambeau R.
Fifield
Wauboo
Park Falls
Phillips
Worcester
Ogema
Prentice
Tomahawk
Rhinelander
Crescent
Harshaw
Three Lakes
Eagle River
Sugar Camp
Monico
Gagen
Florence
Iron River
Hurley
Mercer
Manitowish
Land O Lakes
Boulder Jct
Eagle L.
Pine L.
Keyes L.
Beaver Lake
Dime
Boom
Wabeno
Laona
Lakewood
Townsend
Suring
Oconto Falls
Stiles
Abrams
Lena
Oconto
Gillett
Pound
Coleman
Pulaski
Green Bay
De Pere
Kewaunee
Carlton
Luxemburg
Casco
Algoma
Dyckesville
Wrightstown
Little Rapids
Howard
Suamico
Pittsfield
Glenmore
Nashville
Forestville
Denmark
Two Rivers
Manitowoc
Newton
Northeim
Centreville
Sheboygan
Wilson
Cedar Grove
Belgium
Port Washington
Ulao
Mequon
Milwaukee
Bayview
Oak Creek
Ives Sta
Racine
Kenosha
Lake Shore Jc
Waukesha
Pewaukee
Lake
Oshkosh
Neenah
Menasha
Appleton
Kaukauna
Little Chute
Kimberly
Combined Locks
Hortonville
Black Creek
Seymour
Hilbert
Chilton
New Holstein
Kiel
Plymouth
Sheboygan Falls
Elkhart Lake
Glenbeulah
Random Lake
Kewaskum
Campbellsport
Fond du Lac
New Cassel
Brandon
Ripon
Berlin
Princeton
Green Lake
Dalton
Omro
Winneconne
Neenah
Menasha
Appleton
Kaukauna
Little Chute
Kimberly
Combined Locks
Hortonville
Black Creek
Seymour
Shiocton
Bear Creek
Clintonville
Embarrass
Waupaca
Weyauwega
Fremont
Manawa
Iola
Scandinavia
Big Falls
Tigerton
Wittenberg
Birnamwood
Aniwa
Antigo
Elcho
Summit Lake
Langlade
Deerbrook
Malcolm
Elmhurst
Stetsonville
Dorchester
Abbotsford
Colby
Unity
Spencer
Marshfield
Withee
Stanley
Chelsea
Rib Lake
Merrill
Wausau
Weston
Rothschild
Mosinee
Kronenwetter
Schofield
Hatley
Athens
Aurora
Edgar
Marathon
Rozellville
Stevens Point
Plover
Whiting
Junction City
Almond
Amherst
Amherst Jc
Nelsonville
Rosholt
Milladore
Auburndale
Arpin
Port Edwards
Nekoosa
Wisconsin Rapids
Grand Rapids
Biron
Wisconsin Dells
Lyndon Sta
Necedah
Port Edwards
Nekoosa
Wisconsin Rapids
Grand Rapids
Biron
Wisconsin Dells
Lyndon Sta
Necedah
Portage
Pardeeville
Lodi
Columbus
Doylestown
Mineral Point
Fox Lake
Juneau
Beaver Dam
Horicon
Mayville
Waterloo
Watertown
Jefferson
Fort Atkinson
Stoughton
Milton
Janesville
Beloit
Whitewater
Elkhorn
Delavan
Lake Geneva
Walworth
Darien
Sharon
Genoa City
Richmond
Burlington
Waterford
Rochester
Wind Lake
Union Grove
Kansasville
Caledonia
Racine
Kenosha
Lake Shore Jc
Milwaukee
Bayview
Oak Creek
Ives Sta
Racine
Country Line
Kenosha
Lake Michigan
Door
Kewaunee
Manitowoc
Sheboygan
Ozaukee
Washington
Waukesha
Jefferson
Dodge
Fond du Lac
Green Lake
Marquette
Adams
Juneau
Wood
Portage
Waupaca
Shawano
Menominee
Outagamie
Calumet
Brown
Kewaunee
Door

Hematite

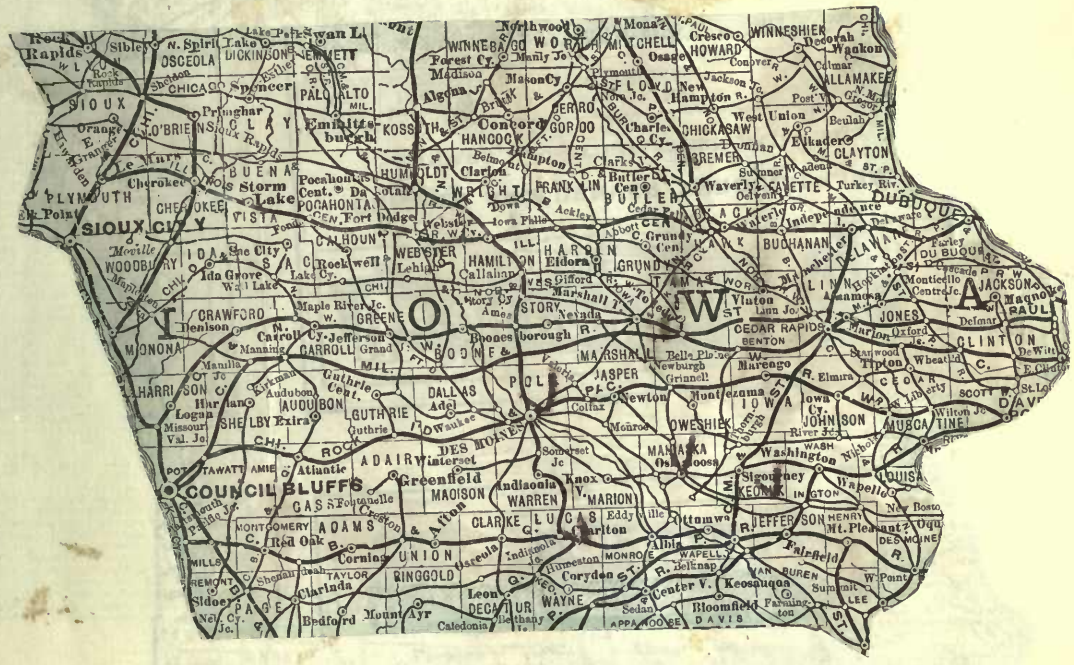
Stone.



Iron

ee 9 d. Hematite. Vermillion Lake

Hematite
Stone.


IOWA
SIOUX CITY
COUNCIL BLUFFS
DES MOINES
DUBUQUE
CEDAR RAPIDS
MARSHALL
POLK
STORY
WOODBURY
PLYMOUTH
CHEROKEE
BUENA VISTA
CALHOUN
WEBSTER
HAMILTON
HARDIN
GRUNDY
BUCHANAN
DELAWARE
CLAYTON
ALLAMAKEE
WINNESHIEK
HOWARD
MITCHELL
WORTH
FLOYD
CERRO GORDO
HANCOCK
WRIGHT
FRANKLIN
BUTLER
BREMER
CHICKASAW
FAYETTE
CLINTON
JACKSON
JONES
LINN
BENTON
TAMA
IOWA
JOHNSON
MUSCATINE
LOUISA
HENRY
JEFFERSON
WASHINGTON
KEOKUK
MAHASKA
POWESHIEK
JASPER
NEWTON
MONROE
MARION
WARREN
MADISON
DALLAS
GUTHRIE
AUDUBON
CARROLL
GREENE
BOONE
CRAWFORD
SHELBY
HARRISON
MONONA
IDA
SAC
CHEROKEE
O'BRIEN
OSCEOLA
DICKINSON
EMMET
KOSSUTH
PALO ALTO
CLAY
SPENCER
LYON
SIOUX
ADAIR
ADAMS
UNION
CLARKE
LUCAS
MONROE
WAPELLO
DAVIS
APPANOOSE
WAYNE
DECATUR
RINGGOLD
TAYLOR
PAGE
FREMONT
MILLS
MONTGOMERY
CASS
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
NEWTON
MONROE
MARION
WARREN
MADISON
CLARKE
LUCAS
WAYNE
DECATUR
RINGGOLD
TAYLOR
UNION
ADAMS
CASS
MONTGOMERY
MILLS
FREMONT
PAGE
ADAIR
GREENE
BOONE
STORY
HARDIN
GRUNDY
TAMA
BENTON
IOWA
JOHNSON
MUSCATINE
LOUISA
DES MOINES
HENRY
JEFFERSON
WASHINGTON
KEOKUK
MAHASKA
POWESHIE

Lead & zinc

Coal

Iron

Type 2. Limonite. Upper Osage River.
" 7 Hematite. Crawford Co, Dent & Phelps Co.
" 10 " Pilot Knob.
" 11 " Iron Mt.

Copper

Type 19. Chalcopyrite, St Genevieve.

Lead.

Type 23. Galena. Bonne Terre & mine la motte.

Lead & Zinc

Type 25. Galena & Zinchlende. Jasper & Newton Co's

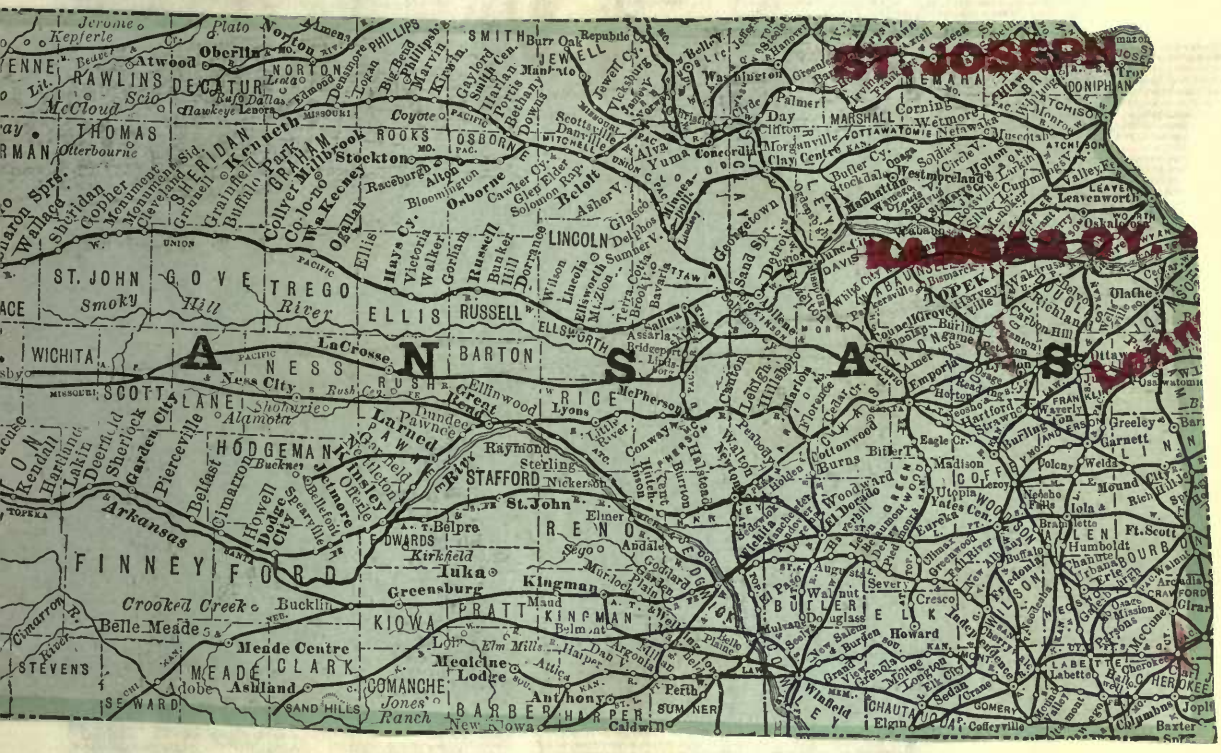
Hematite

Copper

Lead

Zinc

Coal


ST. JOSEPH
KANSAS CITY
TOPEKA
KANSAS
ST. JOHN
GOVE
TREGO
ELLIS
RUSSELL
LINCOLN
BARTON
RICE
NESS
RUSH
PAWNEE
STAFFORD
RENO
HODGEMAN
EDWARDS
PRATT
KINGMAN
KIOWA
COMANCHE
BARBER
HARPER
SUMNER
FINNEY
FORD
GRAHAM
SHERIDAN
THOMAS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
WASHINGTON
MARSHALL
NEMAHA
BROWN
DONIPHAN
ATCHISON
LEAVENWORTH
JACKSON
JEFFERSON
OSAGE
SHAWNEE
DOUGLAS
FRANKLIN
MIAMI
LINN
BOURBON
ALLEN
ANDERSON
WOODSON
GREENWOOD
BUTLER
COWLEY
CHAUTAUQUA
MONTGOMERY
LABETTE
CHEROKEE
CRAWFORD
BOURBON
WILSON
NEOSHO
LABETTE
WOODSON
COFFEY
OSAGE
WABAUNSEE
GEARY
RILEY
POTTAWATOMIE
MARSHALL
NEMAHA
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DONIPHAN
ATCHISON
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DOUGLAS
JOHNSON
WYANDOTTE
LEAVENWORTH
ATCHISON
DONIPHAN
MARION
CHASE
LYON
GREENWOOD
BUTLER
COWLEY
SUMNER
HARPER
BARBER
KINGMAN
PRATT
KIOWA
COMANCHE
CLARK
MEADE
SEWARD
STEVENS
MORTON
HASKELL
GRANT
STANTON
GRAY
FORD
HODGEMAN
EDWARDS
STAFFORD
PAWNEE
RUSH
NESS
TREGO
GOVE
LANE
SCOTT
WICHITA
GREELEY
WALLACE
LOGAN
GOVE
TREGO
ELLIS
RUSSELL
LINCOLN
OTTAWA
CLOUD
MITCHELL
OSBORNE
ROOKS
PHILLIPS
SMITH
JEWELL
REPUBLIC
WASHINGTON
CLAY
RILEY
GEARY
WABAUNSEE
SHAWNEE
OSAGE
COFFEY
WOODSON
ALLEN
ANDERSON
LINN
MIAMI
DOUGLAS
JOHNSON
WYANDOTTE
LEAVENWORTH
ATCHISON
DONIPHAN
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CHASE
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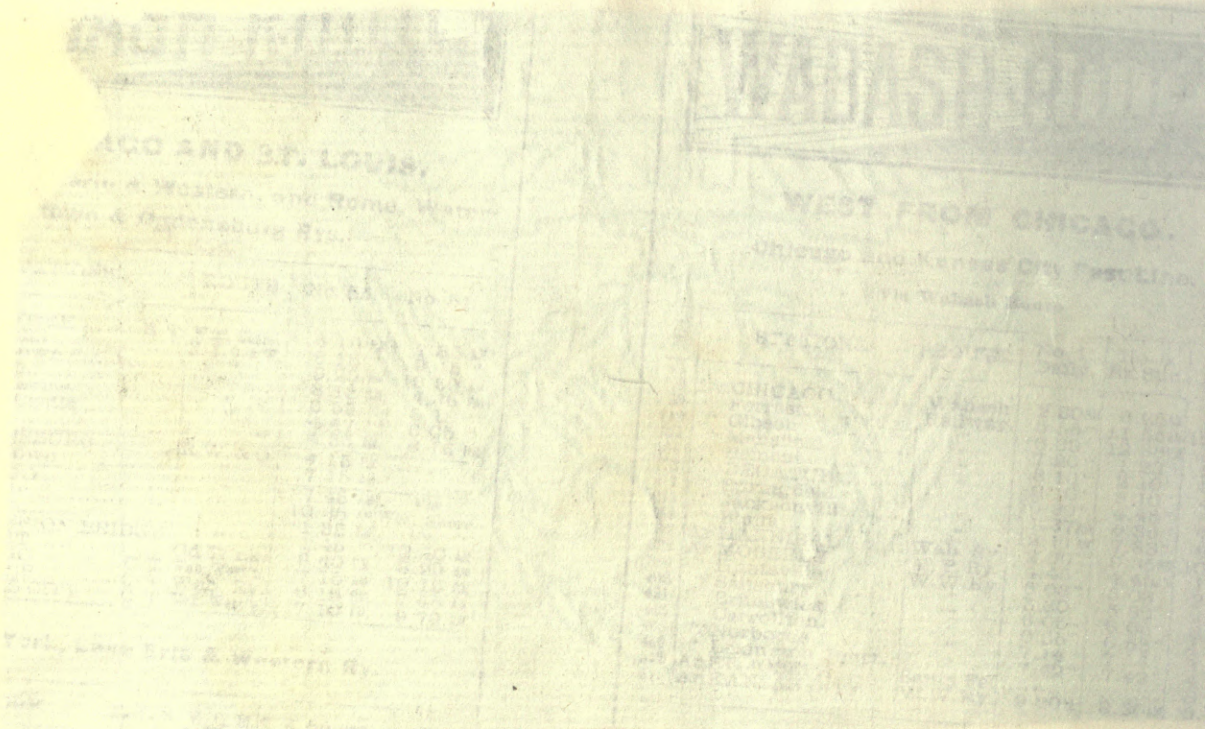
FORD
HODGEMAN
EDWARDS
STAFFORD
PAWNEE
RUSH
NESS
TREGO
GOVE
LANE
SCOTT
WICHITA
GREELEY
WALLACE
LOGAN

Coal

Lead

Zinc

Salt.



Antimony

Type 51a. Stibnite. Sevier Co.

Manganese.

Type 54a. Pyrolusite. Batesville.

Eureka Sprs.
Berryville
Harrison
Huntsville
Fayetteville
Springdale
Rogers
Bentonville
Siloam Springs
Gentry
Decatur
Gravette
Pea Ridge
Bella Vista
Lowell
Centerton
Cave Springs
Elm Springs
Tontitown
Fayetteville
Greenland
West Fork
Prairie Grove
Farmington
Goshen
Winslow
Greenwood
Fort Smith
Van Buren
Alma
Mulberry
Ozark
Charleston
Paris
Ozark
Clarksville
Lamar
Hartman
Coal Hill
Knoxville
Scottsville
Russellville
Dover
Atkins
Pottsville
Appleton
London
Dardanelle
Boonville
Waveland
Alpha
Danville
Sugar Grove
Petit Jean
Waldron
Briggsville
Nebraska
Gravelly Hill
Quidam
Chula
Boles
Stillwater
Oden
Buckville
Dallas
Big Bend
Mt. Ida
Black Springs
Caddo Gap
Rock Cr.
Venetia Grove
Galena
Kirby
Amity
Hollywood
Murfreesboro
Centre Pt.
Nashville
Mineral Spgs.
Hempstead
Ozan
Wallaceburg
Washington
Prescott
Bluff City
Emmet
Nevada
Hope
Fulton
Clayton
Rosston
Human
Falcon
Delta
Texarkana
Garland City
Lewisville
Buckner
Waldo
Stephens
Mena
Mt. Ida
Magnolia
Fairland
Canfield
Bright Star
Bradley
Walnut Hill
Eden
Atlanta
Plainfield
McNeil
Champagnolle
Mt. Holly
Nalls
El Dorado
New London
Three Creeks
Hillsboro
Blanchard Springs
Omaha
Burlington
Oregon
Clifty
Batavia
Clear Creek
Osage
Bellefonte
Hill Top
Dumsmore
Mt. Hersey
Saint Joe
Kingston
Aurora
Jasper
Mt. Parthenon
Delaney
Cassville
Quincy
Witts Sprs.
Fallsville
Cobbville
Mt. Levi
Hagerville
Freeman
Laurel
Liberty Springs
Scottsville
Lick Mountain
Roseville
Delaware
Hobart
Oakland
Lead Hill
Doddsville
Yellville
Toney
Duggers Mills
Providence
Marshall
Sylamore
Blue Mtn.
Oak Flat
Copeland
Middle Settlement
Clinton
Rose Bud
Morrilton
Plumerville
Menifee
Conway
Petit Jean
Perryville
Nimrod
Jessieville
Palla
Fourch
Chula
Brazils
Totten
Argenta
Little Rock
Whites Mills
Mountain Valley
Tatumville
Saline
Benton
Bryant
Hot Springs
Mazarn
Lawrence
Gilford
Jefferson Sprs.
Point Cedar
Malvern
Sheridan
Donaldson
Witherspoon
Arkadelphia
Tulip
Princeton
Curtis
Fairview
Gurdon
Bonneau
Holly Sprs.
Wheltel
Sayre
Childester
Dowling
Lilley
Camden
Locust Bayon
Hampton
Fluin
Senter
Gravel Ridge
Mere Bay
Blanchton
Fountain Hill
Milo
Lake Village
Hamburg
Petersburg
Beach Cr.
Bartholomew
Elon
Riply
Harwoods Ldg.
Poplar Bluff
Grand L.
Sterling
Glen
Lacorey
Midway
Collins
Monticello
Tillar
Plantersville
Winchester
Walnut Lake
Lincoln
Dumas
Reedville
Red Fork
Star Cy.
Lear
Rison
Toledo
Cleveland
Kingsland
Ferdyce
Thornton
Andover
Gum Spr.
Ramsey
Pine Bluff
Redfield
Tamo
Grady
Varner
Big Cr.
Grace
Tulip
Brooks
Noble L.
Fairfield
Swan Lake
Bankhead
Racine
Cummins
Arkansas Post
Laconia
Watson
Desha
Winchester
Tillar
Drew
McGehee
Arkansas City
Prairie Grove
Jacksonville
Lonoke
Cabot
Austin
Ward
Beebe
Searcy
Higginson
Kensett
Garner
El Paso
Mt. Vernon
Conway
Faulkner
Hiram
Grand Glaise
Bradford
Russell
Quitman
Heber
Springs
Kinderkook
Cleburne
DeKalb
Pleasant Plains
Olyphant
Jacksonport
Newport
Diaz
Tupelo
Augusta
Judsonia
Bald Knob
Jamestown
Independence
Sulphur Rock
Batesville
Sandtown
Cushman
Mountain View
Melbourne
Evening Shade
Mt. Olive
Anderson
Izard
Sharp
Kings Mills
Highland
Pineville
Iuka
Mitchell
Salem
South Fork
Vidette
Fulton
Alton
Hardy
Mammoth Spr.
Poenhontas
Williford
Ravenden
Imboden
Black Rock
Powhatan
La Crosse
Lawrence
Minturn
Allicis
Sedgwick
Walnut Ridge
Hoxie
Knobel
Randolph
Corning
Boydsville
Rector
Marmaduke
Gainesville
Greene
Paragould
Bethel
Bonner
Jonesboro
Gilkerson
Tuckerman
Obear
Parkin
Wynne Jc.
Harrisburg
Wittsburg
Marion
Crawfordsville
Earle
Hughes
Madison
Palestine
Forrest City
Hickory Ridge
Cherry Valley
Tilton
Wheatley
Clarkton
Fisher
Wiener
Hatchie Coon
Youngville
Poinsett
Lake City
Big Bay Siding
Osceola
Golden Lake
Marked Tree
McGavock
Tyronza
Wilson
Turrell
Gilmore
Crittenden
Cross
Sans Souci
Brolaski
Big L.
Mississippi
Greer
Parma
Kent
Marianna
Lagrange
Holly Grove
Poplar Grove
Helena
Phillips
Indian Bay
Del
Westover
Madoc
St. Charles
Humphreys
Goldman
Stuttgart
Parham
Tomberlin
England
Pulaski
Lonoke
Carlisle
Hazen
DeValls Bluff
Prairie
Cotton Plant
Des Arc
Brinkley
Clarendon
Woodruff
Augusta
Bemis
Colenia
Hunter
Roe
Pine City
Fairmount
Petitus
Alexander
Wrightsville
Sweet Home
Scott
Calhoun
Kerr
Galloway
Roland
Woodson
Hensley
Redfield
Talkwood
Gilford
Jefferson Sprs.
Samples
Althelmer
Rob Roy
DeWitt
Arkansas
St. Louis Ldg.
Madoc
Phillips
Helena
Poplar Grove
Marianna
Lagrange
Holly Grove
Clarendon
Brinkley
Woodruff
Augusta
Bemis
Colenia
Hunter
Crawfordsville
Earle
Hughes
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McGavock
Tyronza
Wilson
Turrell
Sans Souci
Brolaski
Big L.
Mississippi
Greer
Parma
Kent
Gainesville
Marmaduke
Rector
Boydsville
Corning
Moark
St. Francis
Greer
Arkansas
Lawrence
Randolph
Clay
Greene
Craighead
Poinsett
Cross
Crittenden
St. Francis
Lee
Phillips
Monroe
Prairie
Woodruff
White
Jackson
Independence
Izard
Sharp
Fulton
Baxter
Marion
Boone
Newton
Searcy
Stone
Van Buren
Cleburne
Faulkner
Conway
Pope
Yell
Perry
Scott
Montgomery
Polk
Garland
Hot Spring
Grant
Saline
Pulaski
Lonoke
Prairie
White
Jackson
Woodruff
Cross
Poinsett
Lee
Phillips
Monroe
Arkansas
Desha
Chicot
Ashley
Drew
Lincoln
Jefferson
Bradley
Calhoun
Ouachita
Union
Columbia
Lafayette
Miller
Little River
Hempstead
Howard
Pike
Clark
Dallas
Nevada
Lafayette
Miller
Columbia
Union
Ashley
Chicot
Desha
Drew

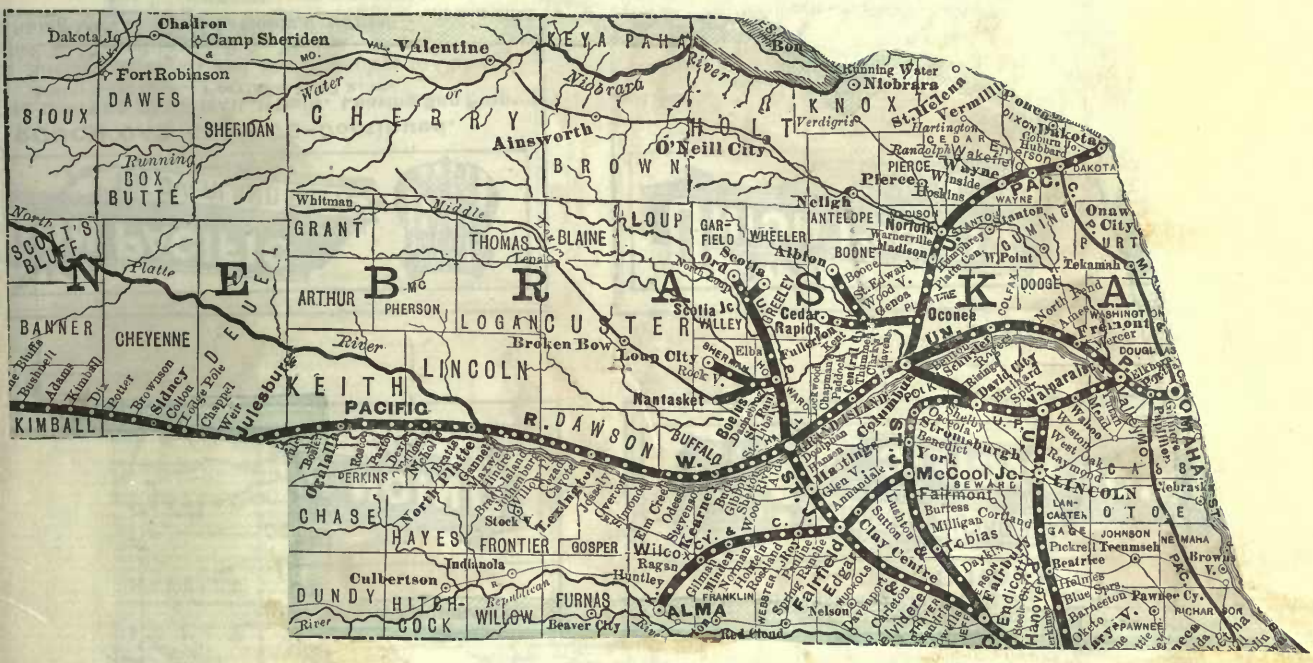
Coal

Lead

Zinc

manganese

Antimony.


NEBRASKA
Chadron
Camp Sheridan
Valentine
Fort Robinson
DAWES
SIOUX
SHERIDAN
CHERRY
KEYA PAHA
Niobrara
Running Water
KNOX
Ainsworth
O'Neill City
HOLT
BROWN
Running Water
BOX BUTTE
Whitman
GRANT
THOMAS
BLAINE
LOUP
GARFIELD
WHEELER
Nelligh
ANTELOPE
Norfolk
Madison
Albion
BOONE
Scotia
Ord
Cedar Rapids
Oconee
DODGE
Fremont
Tekamah
Onawa
SCOTT'S BLUFF
BANNER
CHEYENNE
ARTHUR
McPHERSON
LOGAN
CUSTER
Broken Bow
Long City
Nantasket
LINCOLN
KEITH
PACIFIC
R. DAWSON
Julesburg
KIMBALL
Platte
River
DUEL
Valparaiso
David City
Schuyler
Columbus
York
McCool Jc.
SEWARD
Fairmont
Milligan
Tobias
Strausburgh
Benedict
Hastings
Glen V.
Clay Centre
Edgar
Fairfield
Ong
Hubbell
Deshler
Belvidere
Hebron
Fairbury
Endicott
Hanover
Beatrice
Blue Springs
Barneston
Pawnee Cy.
LINCOLN
OTOE
JOHNSON
NEMAHA
Tecumseh
Brownville
PERKINS
CHASE
HAYES
FRONTIER
GOSPER
Stockville
Indianola
Culbertson
Wilcox
Ragan
Huntley
Oxford
Orleans
Alma
FURNAS
Beaver City
DUNDY
HITCHCOCK
WILLOW
Republican
Red Cloud
FRANKLIN
WEBSTER
NUCKOLLS
CLAY
FILLMORE
SALINE
JEFFERSON
GAGE
PAWNEE
RICHARDSON
Falls City
Humboldt
Table Rock
Pawnee City
Lewiston
Dawson
Gilmore
Wisner
Pilger
Stanton
Norfolk
Madison
Wayne
Pierce
Hartington
Verdigris
Vermillion
Dakota Co.
Dixon
Cedar
Knox
Randolph
Wakefield
Emerson
Hubbard
Goldenrod
Winside
Hoskins
Wakefield
Carroll
Hartington
Creighton
Niobrara
Verdigris
St. Helena
Vermillion
Dakota City
Covington
Homer
Sioux City
Jackson
Onawa
Whitman
Middle
North
Platte
River
Water
or
Running
Box Butte
Scotts Bluff
Bushnell
Dix
Potter
Brownson
Sidney
Chappel
Lodge Pole
Weir
Duel
Julesburg
Kimball
Adams
Kimball
Chase
Perkins
Keith
Lincoln
Logan
Custer
Arthur
McPherson
Thomas
Blaine
Loup
Garfield
Wheeler
Valley
Greeley
Sherman
Howard
Buffalo
Dawson
Gosper
Phelps
Kearney
Franklin
Webster
Nuckolls
Clay
Fillmore
Saline
Jefferson
Gage
Johnson
Nemaha
Otoe
Lancaster
Seward
Polk
Butler
Saunders
Colfax
Platte
Nance
Boone
Greeley
Wheeler
Garfield
Loup
Blaine
Thomas
Grant
Hooker
Dundy
Hitchcock
Red Willow
Furnas
Harlan
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
Saline
Jefferson
Gage
Johnson
Nemaha
Otoe
Lancaster
Seward
York
Polk
Butler
Saunders
Colfax
Platte
Nance
Boone
Greeley
Wheeler
Garfield
Loup
Blaine
Thomas
Grant
Hooker
Dundy
Hitchcock
Red Willow
Furnas
Harlan
Franklin
Webster
Nuckolls
Thayer

UNION PACIFIC
THE OVERLAND ROUTE
UNION PACIFIC
THE OVERLAND ROUTE
UNION PACIFIC

Lead - Silver

Type 33a. Galena &c. Black Hills.

~~Silver~~ Gold.

Type 38 Placers. Black Hills.

3

Gold
Silver
Tin
Mica

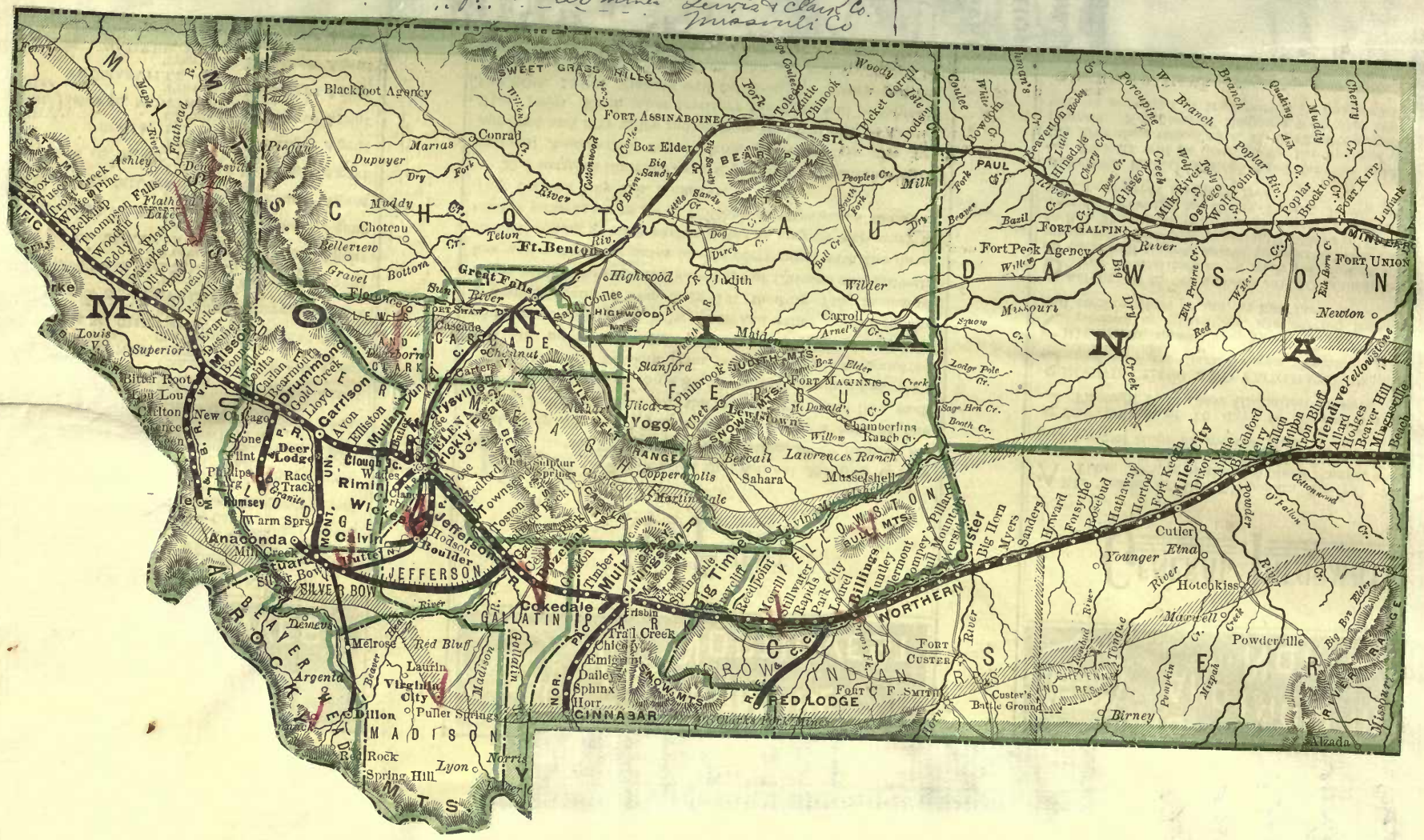
} Black Hills

Type 17. Copper sulphides. Butte.
Lead & Silver.

Type 33. Oxides. Wickes.

Type 39a. Silver Madison Co
" 39b Auriferous Qz. Beaver Head Co.
" 39c " Quartz. Jefferson Co.
" 39d with Cu. Silver Bow Co.
" 39e. Placer deposits. Deer Lodge Co.
" 39f. Placer mines Lewis & Clark Co.
Missouri Co

Lignite — Bozeman, Gallatin Co.


MONTANA
Blackfoot Agency
Conrad
Dupuyer
Choteau
Ft. Benton
Great Falls
Highwood
Judith
Carroll
Fort Assinaboine
Box Elder
Fort Peck Agency
Fort Galpin
Fort Union
Newton
Missouri
Milk
Marias
Muddy Cr.
Teton
Sun River
Cascade
Chestnut
Stanford
Philbrook
Judith Mts.
Fort Maginnis
Vogo
Chamberlins
Ranch Cr.
Lawrences Ranch
Bercail
Sahara
Musselshell
Coppercopolis
Martinsdale
Yellowstone
Glendive
Miles City
Custer
Big Horn
Myers
Sanders
Forsythe
Rosebud
Hathaway
Horvid
Fort Keogh
Dixon
Ashland
Sanford
Miles
Milton
Iron Bluff
Allard
Holmes
Beaver Hill
Miltersville
Beach
Cutler
Younger
Etna
Hotchkiss
Maxwell
Powderville
Birney
Alzada
Custer's Battle Ground
Fort C F Smith
Fort Custer
Crow Ind. Res.
Northern Cheyenne Ind. Res.
Big Timber
Livingston
Bozeman
Gallatin
Jefferson
Boulder
Rimini
Wickes
Clancy
Helena
Townsend
Radersburg
Diamond City
Canyon Ferry
Craig
Cascade
Carter's
Augusta
Choteau
Dupuyer
Dearborn
Gold Creek
Drummond
Garrison
Elliston
Avon
Lloyd
Bearmouth
Clinton
Missoula
Bonner
Frenchtown
Superior
Louis
Bitter Root
Lou Lou
Carlton
New Chicago
Stone
Flint
Philipsburg
Race Track
Ramsey
Warm Spgs
Anaconda
Mill Creek
Stuart
Butte
Silver Bow
Deer Lodge
Clough
Wades
Jericho
Ricky
Pioneer
Argenta
Melrose
Red Bluff
Laurin
Virginia City
Dillon
Puller Springs
Red Rock
Spring Hill
Lyon
Norris
Cokedale
Trail Creek
Chicory
Emigrant
Dailey
Sphinx
Horr
Cinnabar
Red Lodge
Quarles Petrified Forest
Timber Line
Mill Creek
Absaroka
Beaverhead
Madison
Gallatin
Park
Stillwater
Rapids
Park City
Laurel
Billings
Huntley
Vermont
Pompey's Pillar
Crow Agency
Custer
Northern
Yellowstone
Powder
Tongue
Rosebud
Big Horn
Little Big Horn
Pryor Mts.
Big Snowy Mts.
Little Belt Mts.
Judith Mts.
Crazy Mts.
Bull Mts.
Pryor Mts.
Big Snowy Mts.
Snowy Mts.
Belt Mts.
Big Belt

Iron.
Copper
Lead.
Silver
Gold.

Copper

Type 209. Oxides. Laramie Range.

Coal

nite Rock Springs

" Evanston.

Magnetite
Gold.
Coal.

Iron.

Type 2. Limonite. Hot Spgs. Saguache Co.
" 13 a Magnetite. Several counties.

Copper

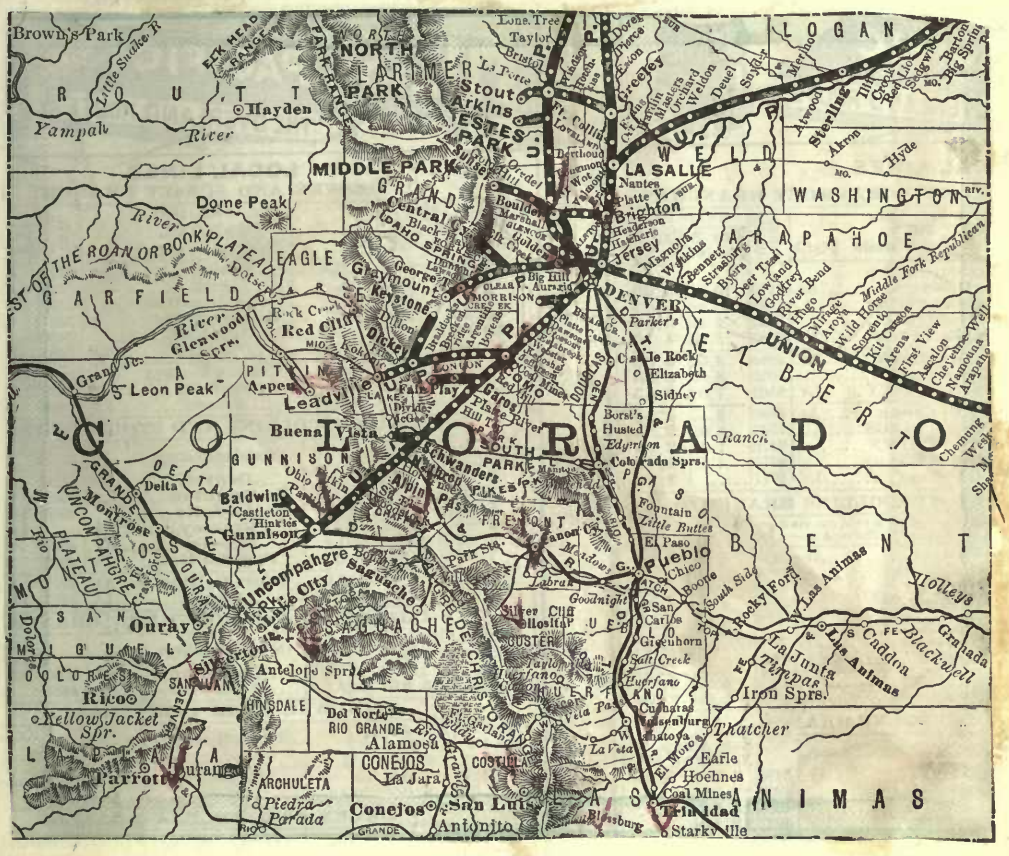
Type 16 b. Chalcopyrite & Bornite. Gilpin Co

Lead-Silver.

Type 32. Oxides. Leadville
" 32 a " Aspen
" 32 b " Ten Mile
" 32 c " Red Cliff. Eagle Co.

Silver

Type 37. In Quartz veins. San Juan Regn
" 37 a Sulphides &c. Gunnison
" 37 b Quartz veins Eagle Co
" 37 c Argent. galena Summit Co
" 37 d Gold Park Co.
" 37 e & f Silver Rio Grande Co.
" 37 h argent. galena Custer Co.
" " tellurides &c Clear Creek Co.
Boulder Co.



Coal

Lignite Trinidad, Las Animas Co.
" Walsenburg, Huerfano Co
" Canon City, Fremont Co

" Como, Jordan Co
" Durango, La Plata Co
" Elk Mtns, Gunnison Co

Iron
Copper
Lead.
Silver
× ~~Zinc~~
Gold
Coal
Petroleum.

Lead – Silver

ype 32. Oxides. Magdalena Mts. Donna Ana Co

Silver.

ype 36a. Ag + Au in SO_2. Grant Co.
" " " " Burro & Santa Rita Mnts.
" " Gold Lincoln Co.
" " Silver Socorro Mts.
" " " Santa Fe Co & Colfax Co.

Coal.

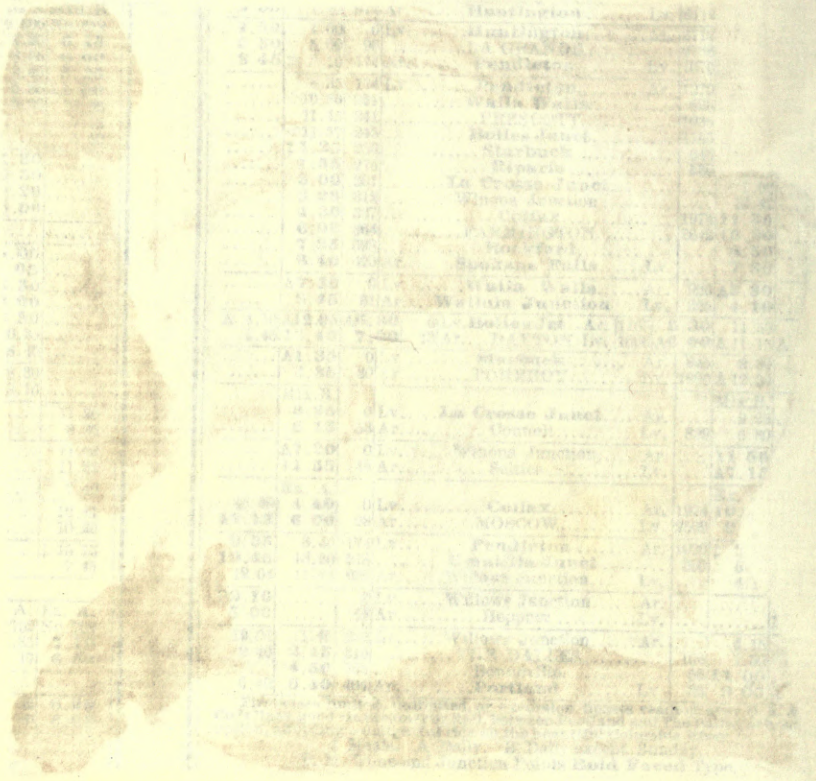
Donna Ana Co
thracite. Silver City. Grant Co.
ingcoals. Carthage, Socorro Co
" Valencia Co
" Bernalillo Co

Coal.

Lignite Santa Fe. Co,
" Taos Co
" Raton. Colfax Co

NEW MEXICO
Wallace
Aztec
Flora Vista
Farmington
Sulphur Spring
Gigantes
SAN JUAN
RIO ARRIBA
Sulphur Spring
Laguna Negra
Los Brazos
Los Ojos
Fort Lowell
La Puente
Ensenada
Tres Piedras
Cangillon
Servilleta
Cueva Spr.
El Rito
Los Espinosos
Camonas
Caseta
Cebolla
Lorenzo
Cuchilla
San Juan
Chamita
Volcan
Tio Ortez
Hill
Agua
Palmilla
Colorado
Capulin
Cabezon
Hondo
Los Montes
Cimarron
Fernandez de Taos
Ryados
Sweetwater
Arranca
Las Colinas
Ocate
Elkins
Clifton
Maxwell
Raton
Dillon
Otero
Madison
Mexican Town
Triumph
Klowa
Granite
Dutch Creek
Dorsey
Springer
Franklin
Chicoso
Sharps Claim
Chacez Claim
COLFAX
Spring
Pioneer
Levy
Wagon Mound
Tipton
Spring
Shoemaker
Alcalde
Mora
Rancho
Espanola
SANTA FE
Jemez Hot Spr.
Canoncita Village
Cabezon
Cuchero
Algodones
Wallace
Lanes
Bernalillo
La Guera
Gallinas
Hot Spr.
Romero
Las Vegas
Sulzbacher
Bernal
Pecos
Sabinoso
Mule Spring
La Cinta
Red River Spr.
Conchas
Cebra Spr.
Cabino Spr.
Ft. Bascom
Gallinas Spr.
Pajarito
Santa Rosa
Ojo Capido
Grant
Ojo del Anil
Water
Las Canadinas
Barrio Mexican Settlement
Los Ojitos Spring
Puerto de Luna
Gallisteo
Pedernal
Herrendo Spr.
Estancia Spr.
Otero Ranch
Ruins of Quarro
Spring Negra Spr.
Albuquerque
Isleta
Los Lunas
Tome
Los Chaves
Belen
Casa Colorado
Sabinal
Las Nutrias
La Joya
Alamillo
Subino
Escondido
Socorro
Chapaderos
San Antonio
Carthage
Luis Lopez
Magdalena
Old Ft. Tule Rosa
Socorro Mines
Polvodera
Limitar
Soda Spring
Thompson's Spr.
Oak Spring
Spring
Pond
Sweetwater Spr.
Deep Spr.
Spring
Crater
ZUNI PLATEAU
Bacas Ranch
Acoma
El Rito
San Jose
Rio Puerco
Rio Puerco
Old Zuni
Zuni
Old Ft. Wingate
Pescado Spr.
Ft. Wingate
Rock Spr.
Crane's
Continental Divide
Wingate P.O.
Chaves
Blackwater
Grant's
Victoria Spr.
Ruins
Navaho
Defiance
Carizo Spr.
Gallup
Nutria
Acoma
McCarty's
Cubero
Durans
Atrisco
Alameda
Pajarito
Sedillo
PACIFIC
Buffalo
Guerrero
Sandia
Bernalillo
Algodones
Cabezon
Wallace
Lanes
Jemez Hot Spr.
Canoncita Village
Rock Spr.
Crane's
Continental Divide
Wingate P.O.
Chaves
Blackwater
Grant's
Victoria Spr.
Ruins
Navaho
Defiance
Carizo Spr.
Gallup
Nutria
Acoma
McCarty's
Cubero
Durans
Atrisco
Alameda
Pajarito
Sedillo
PACIFIC
Buffalo
Guerrero
Sandia
Albuquerque
Isleta
Los Lunas
Tome
Los Chaves
Belen
Casa Colorado
Sabinal
Las Nutrias
La Joya
Alamillo
Subino
Escondido
Socorro
Chapaderos
San Antonio
Carthage
Luis Lopez
Magdalena
Old Ft. Tule Rosa
Socorro Mines
Polvodera
Limitar
Soda Spring
Thompson's Spr.
Oak Spring
Spring
Pond
Sweetwater Spr.
Deep Spr.
Spring
Crater
ZUNI PLATEAU
Bacas Ranch
Acoma
El Rito
San Jose
Rio Puerco
Rio Puerco
Old Zuni
Zuni
Old Ft. Wingate
Pescado Spr.
Ft. Wingate

Silver
Gold
Copper



Iron

Type 14. Magnetite & hematite. Iron Co.

Copper

Type 20 a. oxides. Cisco on Mammoth

Lead & Silver

Type 29. Oxides. Bingham & Big & Little Cottonwood Canyons

29 a " Tooele Co

Type 41 a. Ore in Quartzite. Summit Co, Salt Lake Co, Tooele, Beaver, Juab

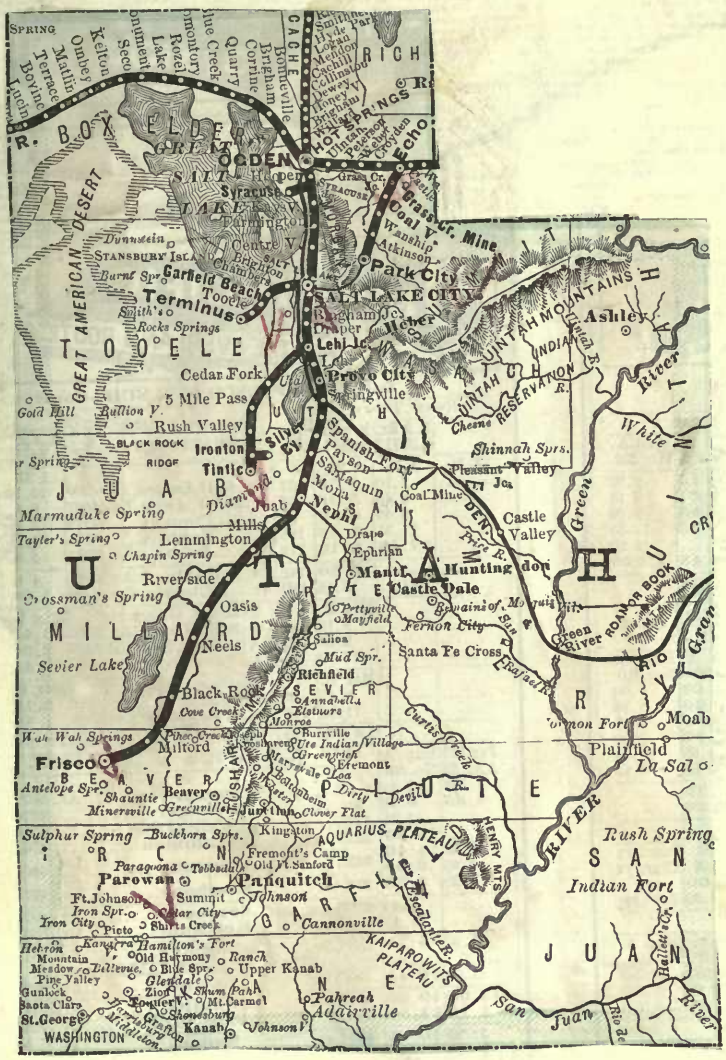
" 41 b. Native. Silver Reef.

Antimony

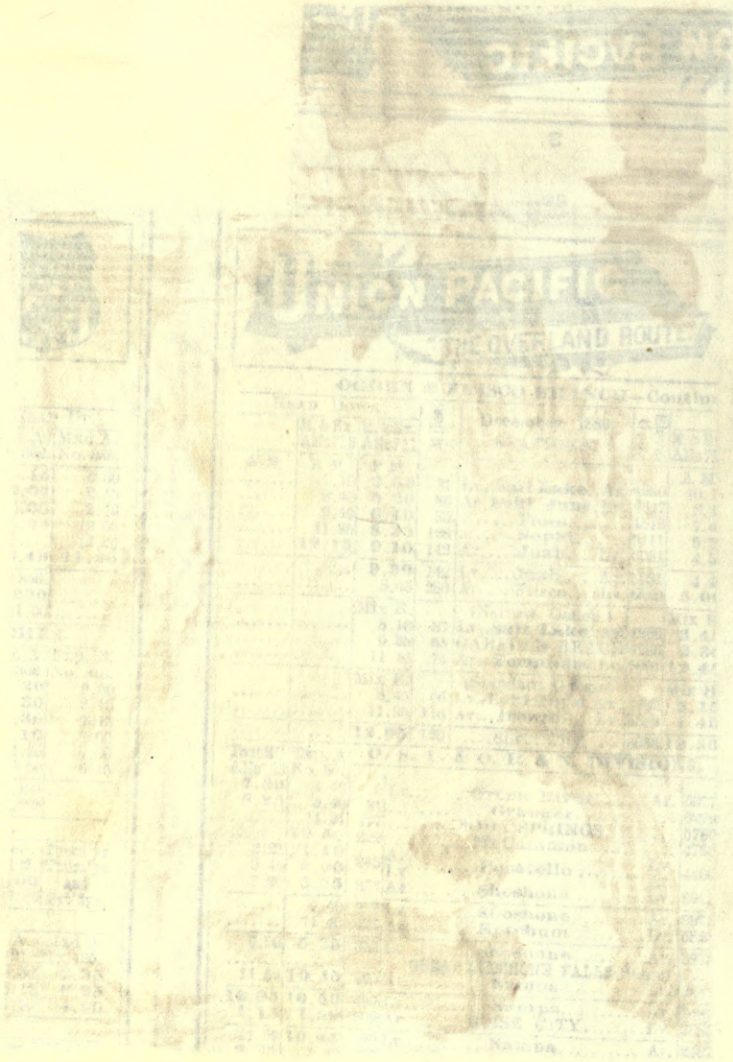
Type 52. Stibnite. Iron Co.

Coal.

Pleasant Valley Mines
Schofield.
San Pete Mines
Cedar City, Iron Co.
Coalville
Grass Creek Mine.



Lead.
Silver
Magnetite
Coal
Sulphur



Lead ...

pe 31. Oxides. Eureka.

Silver & Gold.

pe 43. Ag, lead ores. Lincoln Co

43a Silver Chlorides Nye Co.

43b " " White Pine Co.

" " lead Eureka Co.

43c. ruby silver. Lander Co.

Type 43c. High grade silver ores. Elko Co.

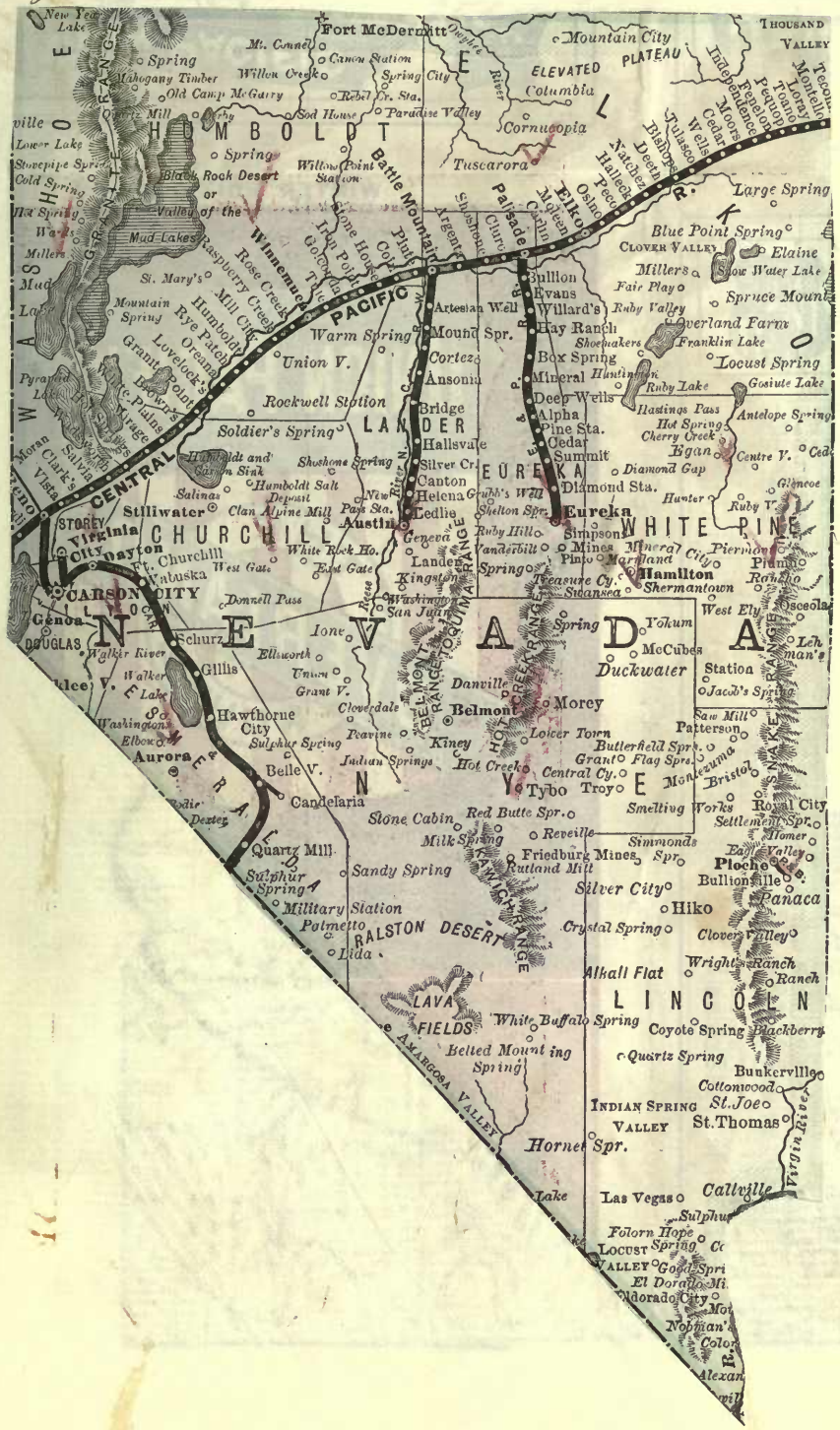
" " Silver & Gold. Humboldt & Washoe Co's

" " Gold & Silver. Churchill, Esmeralda, Storey & Lyon C

Type 44. " " Comstock Lode.

Antimony

Type 57b. Stibnite in gritty gangue. Humboldt C


Fort McDermitt
Mountain City
Thousand Valley
Mt. Conner
Canon Station
Spring City
Willow Creek
Rebel Cr. Sta.
Sod House
Paradise Valley
Cornucopia
Tuscarora
Elevated Plateau
Columbia
Independence
Pequop
Toano
Tecoma
Moriello
Humboldt
Mahogany Timber
Old Camp McGarry
Quinn River
Lower Lake
Stovepipe Spr.
Cold Spring
Ice Spring
Willow Point Station
Black Rock Desert
or Valley of the
Mud Lakes
Millers
Battle Mountain
Pinto
Crescent
Shoshone
Church
Palisade
Carlin
Osino
Tecoma
Hallelch
Wells
Cedar
Moors
Pilot
Large Spring
Blue Point Spring
Clover Valley
Elaine
Slow Water Lake
Millers
Fair Play
Spruce Mount
Ruby Valley
Overland Farm
Franklin Lake
Locust Spring
Gosiute Lake
Antelope Spring
Hot Spring
Cherry Creek
Centre V.
Diamond Gap
Diamond Sta.
Hunter
Glencoe
Ruby V.
Pioche
Piermont
Pianno
Rancho
Hamilton
Shermantown
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Simpson
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Pinto
Mines
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Ruby Hill
Geneva
Landers
Spring
Kingston
Washington
San Juan
Reese
Shelton Spr.
Grubb's Well
Hallsvale
Silver Cr.
Canton
Helena
Ledlie
Pass Sta.
Austin
Clan Alpine Mill
Deposit
Humboldt Salt
Shoshone Spring
Rockwell Station
Soldier's Spring
Bridge
Ansonia
Cortez
Mound Spr.
Warm Spring
Union V.
Artesian Well
Willard's
Hay Ranch
Shoemakers
Box Spring
Mineral Hunting
Deep Wells
Alpha
Pine Sta.
Cedar
Summit
Hegan
Bullion
Evans
Lander
Eureka
White Pine
Stillwater
Virginia City
Dayton
Ft. Churchill
Churchill
Storey
Carson City
Genoa
Douglas
Nevada
Schurz
Walker River
Gillis
Ellsworth
Union
Grant V.
Walker Lake
Hawthorne
Sulphur Spring
Aurora
Belle V.
Candelaria
Dexter
Quartz Mill
Sulphur Spring
Military Station
Palmetto
Lida
Ralston Desert
Lava Fields
Alkali Flat
Wright's Ranch
Ranch
Lincoln
White Buffalo Spring
Coyote Spring
Blackberry
Quartz Spring
Belted Mountain Spring
Bunkerville
Cottonwood
Indian Spring
St. Joe
Valley
St. Thomas
Hornet Spr.
Las Vegas
Callville
Lake
Sulphur
Virgin River
Colorado
Alexandria
Owyhee
Mahogany Timber
Old Camp McGarry
Willow Creek
Rebel Cr. Sta.
Sod House
Paradise Valley
Cornucopia
Tuscarora
Elevated Plateau
Columbia
Independence
Pequop
Toano
Tecoma
Moriello
Humboldt

Lead.
Silver
Gold
Mercury
Sulphur

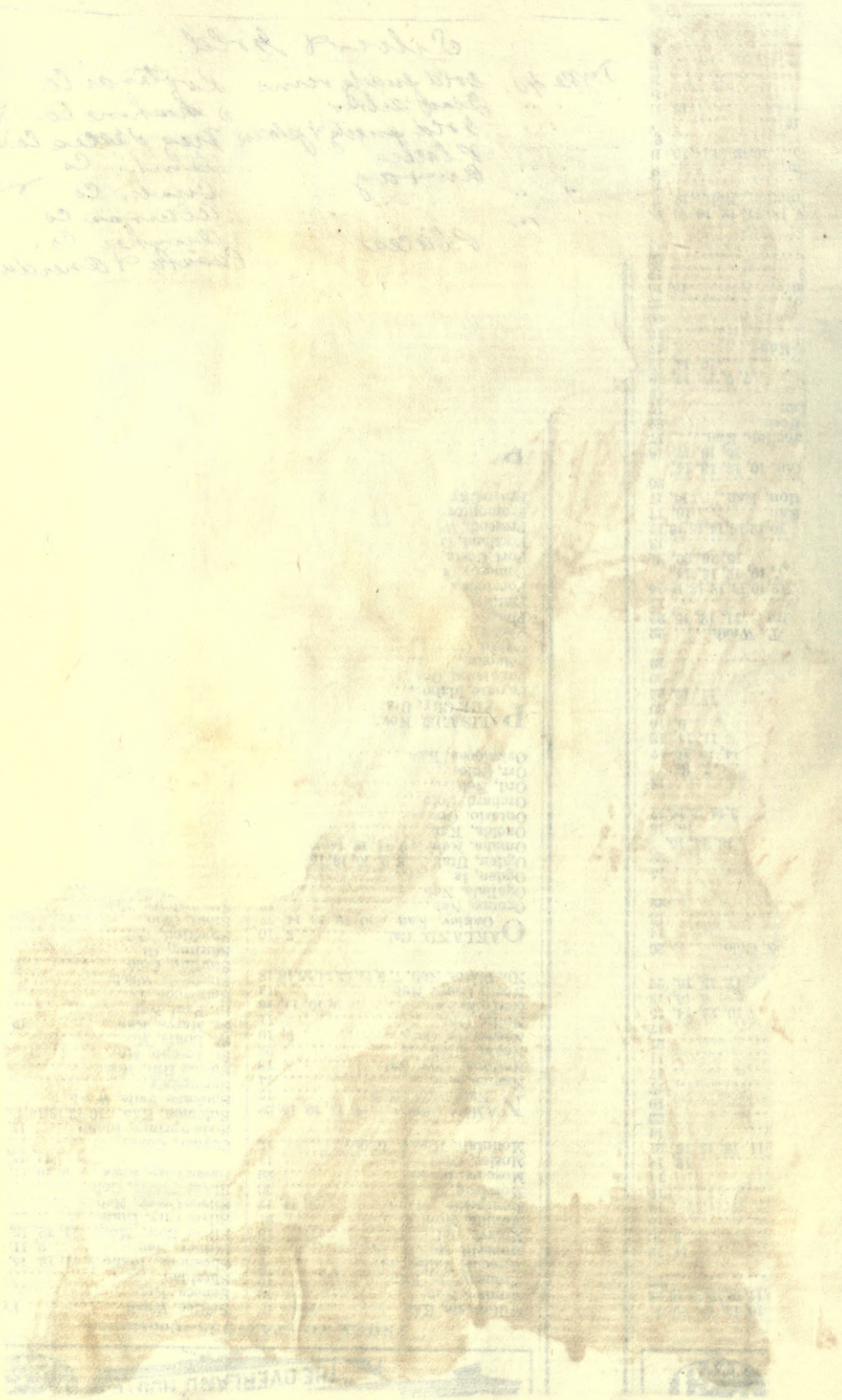
Lead & Silver

Type 34. Argent. galena. Wood River
" 34a " " Coeur d'Alene.

Silver & Gold.

Type 40. Gold quartz veins. Kootenai Co.
" " Lead silver " Shoshone Co.
" " Gold quartz & placer " Nez Perces Co.
" " Placers " Lemhi Co
" " Antag " Custer Co
" " " Alturas Co
" " Placers " Owyhee Co.
" " " Cassia & Oneida Co

Lead:
Silver
Gold.



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Maple Bay
Friday Harbor
Whatcom
Mt. Baker
Lynden
Cedar Cr.
Ship I.
Fidalgo
La Conner
Mt. Vernon
Crescent Harbor
Dungeness
Port Townsend
Cape Johnson
OLYMPIC MTS.
JEFFERSON
Pt. Townsend
Port Ludlow
Port Gamble
Port Madison
SNOHOMISH
Snohomish
Cady V.
Seattle
Fall Cy.
New Castle
Renton
KITSAP
Union City
Port Orchard
Agency
Port Angeles
Port Discovery
Port Townsend
Port Townsend
Port Ludlow
Port Gamble
Port Madison
Seattle
Fall Cy.
New Castle
Renton
KITSAP
Union City
Port Orchard
Agency
Port Angeles
Port Discovery

Gold

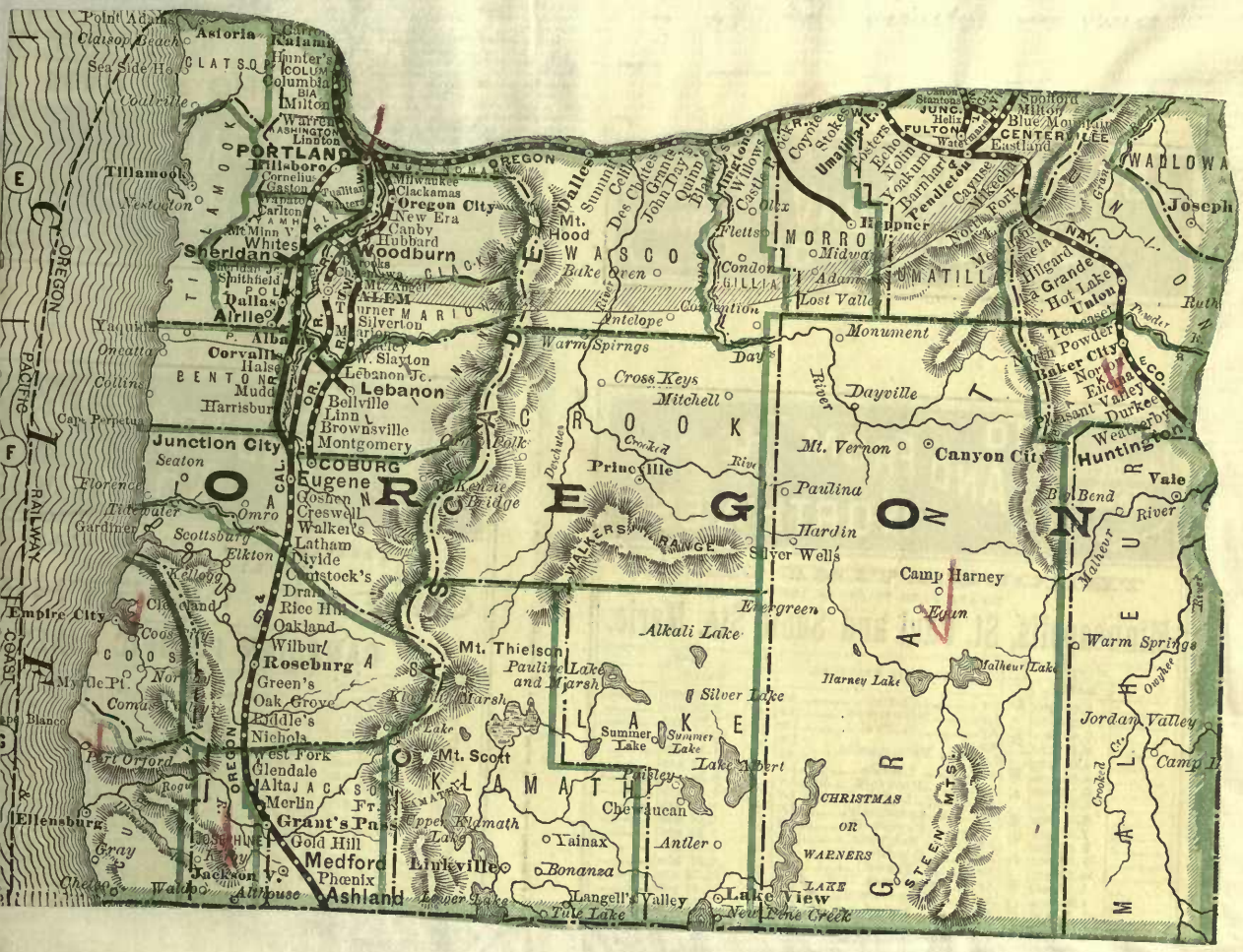
Coal.

Limonite

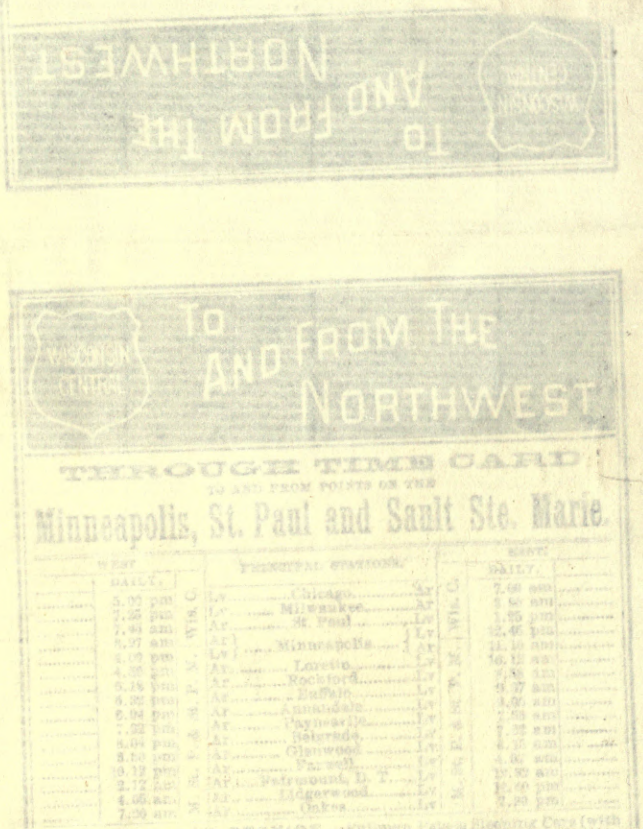
Iron

Type 1 b. Limonite, near Portland.
Gold & Silver.

Type 4 3. Gold placers. Baker, Grant & Josephine Cos
" 43a Au. Black Sands. Port Orford



Gold
Silver
Coal.


To And From The Northwest

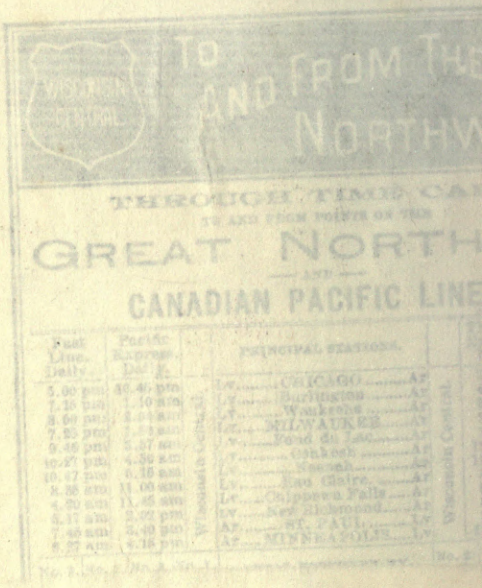
THROUGH TIME CARD

TO AND FROM POINTS ON THE

Minneapolis, St. Paul and Sault Ste. Marie.

WEST DAILY			PRINCIPAL STATIONS.		EAST DAILY	
3.00 pm	10.40 pm	C	Lv Chicago Ar	C	7.40 am	10.40 pm
7.25 pm	1.10 am	M	Lv Milwaukee Ar	M	1.45 pm	7.10 am
7.40 am	1.10 am	M	Ar St. Paul Lv	M	12.40 pm	7.10 am
8.07 am			Ar Minneapolis Lv		11.40 pm	
4.10 pm			Lv Minneapolis Ar		11.10 pm	
4.30 pm	2.37 am	M	Ar Loretto Lv	M	10.52 am	2.37 am
5.15 pm	3.37 am	M	Ar Rockford Lv	M	9.57 am	1.37 am
6.32 pm	4.50 am	M	Ar Buffalo Lv	M	8.40 am	12.20 am
6.04 pm	4.50 am	M	Ar Annandale Lv	M	8.40 am	12.20 am
7.32 pm	6.18 am	M	Ar Cayuga Jc. Lv	M	7.25 am	11.05 pm
8.04 pm	6.18 am	M	Ar Belvidere Lv	M	7.25 am	11.05 pm
8.10 pm	6.18 am	M	Ar Glenwood Lv	M	7.25 am	11.05 pm
10.12 pm	8.00 am	M	Ar Pt. Edwards Lv	M	5.45 am	9.00 pm
2.12 pm	12.00 m	M	Ar Fairmount, D. T. Lv	M	1.45 am	5.00 pm
4.05 pm	1.50 pm	M	Ar Edgewood Lv	M	12.00 m	3.15 pm
7.30 am	5.20 pm	M	Ar Oakes Lv	M	8.30 pm	7.30 pm

THROUGH CAR SERVICE between Chicago and Pembina (with


To And From The Northw

THROUGH TIME CA

TO AND FROM POINTS ON THE

GREAT NORTH

AND

CANADIAN PACIFIC LINE

Fast Line. Daily	Pacific Express Daily Ex. S.		PRINCIPAL STATIONS.		
5.00 pm	10.40 pm	C	Lv CHICAGO Ar	C	
7.15 pm	1.10 am	M	Lv Burlington Ar	M	
8.00 pm	1.10 am	M	Lv Waukesha Ar	M	
7.35 pm	1.10 am	M	Lv MILWAUKEE Ar	M	
9.45 pm	3.37 am	M	Lv Fond du Lac Ar	M	
10.27 pm	4.30 am	M	Lv Oshkosh Ar	M	
10.47 pm	6.18 am	M	Lv Neenah Ar	M	
8.35 am	11.00 am	M	Lv Eau Claire Ar	M	
4.20 am	11.45 am	M	Lv Chippewa Falls Ar	M	
5.11 am	2.02 pm	M	Lv New Richmond Ar	M	
7.45 am	5.40 pm	M	Ar ST. PAUL Lv	M	
8.27 am	6.18 pm	M	Ar MINNEAPOLIS Lv	M	

Iron
Type 14. Magnetite. Sierra & Placer Co
Copper
Type 16 a. Chalcopyrite. Nev. & Amador Co
Silver & Gold.
Type 46. Silver chlorides. Calico Dist.
" 47 Auriferous gravels. Stream beds
" 48. Gold quartz veins. Sierra Nevada & Co
Antimony
Type 51. Vein. Kern Co.
Mercury.
Type 55. New Almaden. Cinnabar
" Idria.
Gold
Silver
Mercury
Iron
Copper
Antimony.
Chromite
Coal
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